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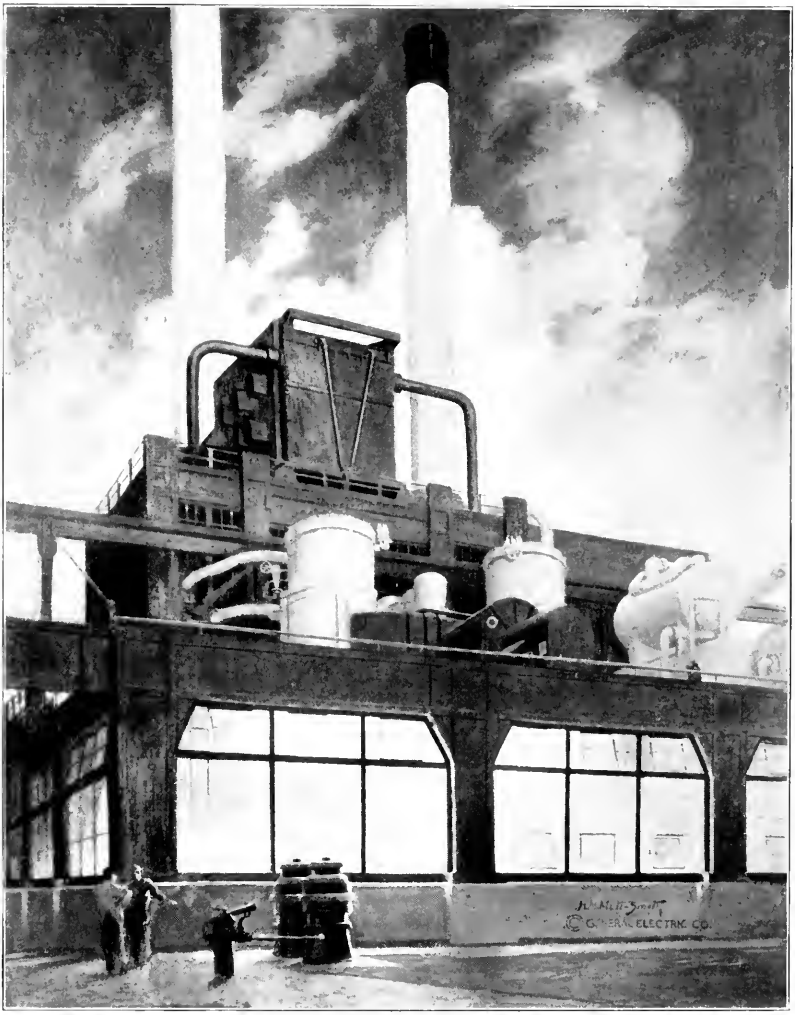


Modern Industry

THE
ARMOUR ENGINEER

NOVEMBER, 1934

The Cascade Tunnel

By GEORGE A. NELSON

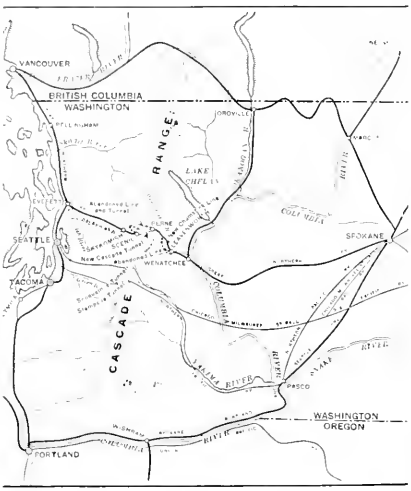
THERE was perhaps no one man of greater importance in opening up the Northwest for railroading than John F. Stevens, a pioneer surveyor for the Great Northern Railroad.

As early as December of 1889, Mr. Stevens explored Marias Pass in the Rocky Mountains, thus opening up a short and low summit route for a line close to the Canadian border. Mr. Stevens did not have an opportunity to complete the location survey over the Rockies, because his success here resulted in his being sent to determine a route for the railroad over the Cascade Range.

In 1890, there was little information available about the Cascade Mountain passes in northern Washington. Inasmuch as the officers of the company wanted the line to open up new territory, Mr. Stevens proceeded to make a thorough examination of the Cascade Range between the Northern Pacific crossing on the south and the Canadian boundary. A reference to the

Editor's Note: George A. Nelson, a senior in the department of Civil Engineering and a member of Chi Epsilon, Tau Beta Pi, and Honor A, is the author of "The Cascade Tunnel." In addition to gaining honors as a student he is also one of the leading athletes of the Institute.

map, Figure 1, will make the problem clearer.



The result of Mr. Stevens' work was the selection of a pass which connected the head waters of Nason Creek with Tye River. The pass had an elevation of 4059 feet. Mr. Stevens selected 2.2% as the maximum grade of the permanent line which was to be located down hill on each side from the portals of a projected tunnel, 2.7 miles long. The summit was to be at the east portal of this tunnel at an elevation of 3383 feet.

The opening of the through line could not be delayed, therefore a switchback route was located over the mountains. This switchback route handled the through traffic of the railroad until December, 1900, when the 2.7 mile tunnel was completed.

As a result of destruction of timber along the route on the west slope, snowslides developed as early as 1903. The problem of protection increased yearly. For this and other economic reasons the possibilities of a route which would entirely avoid the snowslide area, be shorter in length, and have a lower summit, were considered. A very complete study of this problem was made by Mr. E. J. Beard in 1917. Mr. Beard's recommendations included construction of a 14½ or a 17½ mile tunnel and partial electrification of the route. The estimated cost of his plan was about $25,000,000.

The intervention of the war forced the project into the background, but in 1921 discussion of its possibilities was revived. By that time costs had increased so that Mr. Beard's plan would have involved an expenditure in excess of $30,000,000. As a result the company began improvements on the old line.

These improvements included a hydro-electric development in the Tumwater Canyon, and electrification of the tunnel. The success of these improvements prompted the company, in 1925, to consider extending the electrification down the west slope to Skykomish. The limited supply of power available, and the need of variable speed locomotives, resulted in consideration again of the long tunnel plan. It was obvious that if such a project were to be warranted economically it must be the shortest tunnel which would permit the abandonment of all the line on the west slope subject to

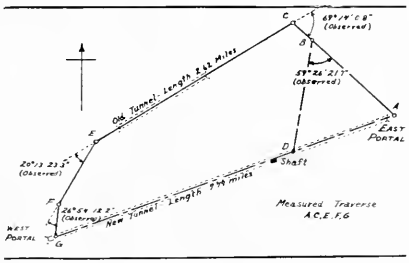
the snowslide menace.

A study made by Mr. Frederick Mears showed that this could be accomplished by a tunnel 7¾ miles long, having its east portal at Berne, Washington, and its west portal at Scenic. Mr. Stevens was called upon to go over the plan, and as a result of an exhaustive study he urged the immediate approval of the eight mile tunnel line as the only justifiable project. Accordingly, in November, 1925, the Board of Directors of the railway company ordered that the tunnel be built.

As a distinct and separate project on the east side of the mountains, a new line (the Chumstick line) was projected from Peshastin (near Leavenworth) to Winton, Washington, a distance of 17 miles. In addition to these major operations, numerous short sections of the line on the east slope, between Winton and Berne, were improved in alignment and grade.

These four pieces of work (1) the 7.79 mile Cascade Tunnel; (2) the Chumstick line; (3) the line revisions between Winton and Berne; (4) the electrification from Wenatchee to Skykomish, constituted a complete program for the improvement of the Cascade crossing.

Surveying parties were put into the field on the west slopes of the Cascades in September, 1925, to locate a line that would meet the general requirements of the problem. The south slope of a ridge, in a bend of the Tye River, affording sufficient cover to "portal under," was finally selected as the west portal site. It was known that the half tion of the differences in elevation be- mile of the new tunnel would lie in a somewhat broken formation, requiring heavy timbering while in course of construction, but it was impossible to better this ground construction and, at the same time, meet other requirements.



PRECISE TRAVERSE, NEW TUNNEL THROUGH THE CASCADE RANGE.

On the east side of the Cascade Range, a portal site was located.

As soon as the east and west portal sites were decided upon, a preliminary survey, an open traverse, was made to connect the portals. The preliminary traverse was extended up Mill Creek valley, and detailed surveys showed that an intermediate shaft could be located in the Mill Creek valley.

The azimuth of the long tunnel, calculated from a more precise second survey, was thrown across the four mountain tops intervening between the portals. This line was used as the preliminary tunnel axis and the pioneer tunnel at the west portal, and the center-heading at the east portal was started by reference to it.

The field work for the "definite location" of the new tunnel resolved it-

self into three problems, namely, first, the establishment of the tunnel axis across the mountain tops and projection of this line into Mill Creek valley at the shaft site, second, the measurement of the tunnel axis and locating the shaft on it, third, the determinatween the east and west portals and the mouth of the shaft. The precise traverse as finally located is shown in Figure 2. A uniform grade of 1.565% was laid through the tunnel, descending from east to west.

In formulating the plan for driving the New Cascade Tunnel, considerable study was given to the method of construction used on the Simplon Tunnel in the Swiss Alps, and, as a result, it was decided to drive a pioneer tunnel between Mill Creek and the west portal.

The Mill Creek shaft divided the tunnel into two segments, the easterly portion being 2.41 miles in length, and the westerly portion, 5.38 miles. A study of time schedules showed that the section of tunnel between the east portal and Mill Creek could be completed within three years by following the center-heading method without the aid of a pioneer tunnel, but that the section of tunnel between Mill Creek and the west portal would require the use of an auxiliary haulageway.

Accordingly, a pioneer tunnel was laid out between the shaft and the west portal, 66 feet to the south of, and parallel with, the center line of the main tunnel. It was considered that this interval provided sufficient distance from the main tunnel to avoid disturbance to the rock formation, without being too far away to complicate the construction of cross-cuts and the movement of spoil trains and construction supplies, back and forth between the pioneer and the main tunnel. In the event of future double track, the pioneer tunnel could be enlarged for second track, as was done in the Simplon Tunnel, or it could be used as a haulage-way from which to attack the new tunnel at intermediate points, as might be required. Likewise, the pioneer tunnel made permanent provision for taking care of the drainage from the main tunnel.

The controlling features of the project, which made it necessary to attack the work simultaneously at several intermediate points between portals, were as follows:

(1) Length of tunnel, 7.9 miles.
(2) Size of tunnel, single-track.
(3) Grade, 1.565%, descending east to west.
(4) Tunnel to be lined with concrete throughout.
(5) Possibility of encountering heavy volume of water.
(6) Time for completion, three years.

The surface indications at the west portal were of such a character that it was practically certain that soft ground would be encountered for a distance of about 1000 feet. To avoid the delay which would result from ex-

cavating through this heavy ground, it was decided to drive a 30 degree incline adit, 251 feet long, from the Tye River Valley to the pioneer tunnel, intersecting the pioneer center line and grade at a point 2279 feet from the west portal. Subsequent developments justified this move, as the material encountered in the pioneer tunnel, west of the adit, was of such a character that the advanced pioneer drifting crews, served from the Tye River incline, had penetrated to a point 5703 feet from the west portal by the time the west portal crews broke through into the advanced drift.

To obtain the location of the tunnel portals for starting the underground operations, the axis of the tunnel, as determined by the line over the mountains, was transferred to a point near each portal by a direction theodolite. In the case of the underground workings near the Mill Creek shaft, the 19 foot base line, plumbed down from the top of the shaft, was used to carry the line forward toward the east and west portals.

All the advanced workings in the main tunnel between the west portal and the Mill Creek shaft were controlled from the pioneer tunnel, both as to line and levels. In following up the main enlargement from the east and west portals, the large direction theodolite, mounted on a six-inch pipe support, was used to give the final line. On account of the heavy smoke, long sights were, as a rule, impossible. Leveling was done with levels having 24-inch telescopes, 4-foot Philadelphia rods being used.

In driving the 10 by 10-foot center heading between the east portal and the Mill Creek shaft, under the instrumental controls previously described, the drifting crews met on March 4, 1927, at a point 3200 feet east of the shaft, 9543 feet west of the east portal. The error of closure was 0.23 feet for "line," 0.2 feet for "grade," and 1.9 feet for "distance."

The tunnel section was determined from Great Northern standards, using a three-centered roof arch and making allowances for insulation against a future 22,000 volt trolley line. External dimensions of sections are variable, depending on the nature of the material and the thickness of the lining required.

The quantity of water encountered in underground operations differed greatly throughout the tunnel, and the permanent drainage system was designed to meet these varying conditions so as to provide ample capacity without unnecessary expense.

The east half of the tunnel was driven through comparatively dry formation, so that from the east portal westward for 3.85 miles, water, entering the tunnel from the 4-inch weep-holes through the concrete lining along both sides of the track, was carried in side ditches. In this distance, there was not a sufficient quantity of water to cause any trouble. At a point 3.85 miles from the east portal the accumulation of water was turned into the pioneer

tunnel by means of a 12-inch pipe, embedded in the south wall of the concrete tunnel lining.

From this easterly cross-drain westerly, for a distance of 2.38 miles, the tunnel passed through a heavy, water-bearing formation, which required that cross-drains to the pioneer tunnel be constructed about every 1500 feet. The pioneer tunnel, therefore, became the permanent artery of the drainage system, into which all water entering the main tunnel between the east portal and the most westerly cross-drain, a distance of 6.23 miles, was diverted. No cross-drains from the main tunnel to the pioneer tunnel were found necessary, from a point 1.56 miles east of the west portal to the west portal, because no heavy, water-bearing formation was encountered in this westerly section.

The bottom of the Mill Creek shaft was filled with concrete to a point 10 feet above the top of the concrete arch tunnel. A 6-inch pipe was placed in the concrete, discharging into the south side ditch of the main tunnel. The Mill Creek shaft was then completely back-filled with the broken rock, removed in the process of sinking the shaft.

Other design considerations included such necessities as refuge and transformer bays, automatic signal systems, telegraph and telephone circuits, tunnel lighting, and overhead trolley. In the actual construction work, drainage and ventilation were the prime factors to be considered in all plans.

Power was supplied at first by portable, gasoline driven air compressors and lighting plants. This was replaced as soon as practicable by power lines from the Tumwater hydro-electric plant on the east side of the divide, and from the Puget Sound Power and Light Company on the west. An emergency generating plant, driven by a 720 H. P. Diesel engine was also installed at the Mill Creek shaft.

The use of explosives, haulage, mucking, the laying of pipe lines, special equipment, concrete lining and numerous miscellaneous construction features—all these were factors of considerable import, and much interesting data is available on these topics, but there is neither room nor reason for such detailed material within the scope of this paper.

For such a construction achievement, total figures, such as the entire amount of excavated material, the number of cubic yards of concrete used, the number of men, the total or partial costs, etc., are dry and sometimes very meaningless. Even though the reader faithfully digests such an array of mathematical statements, he would probably not appreciate the true significance of the work aside from the enormous amount of labor and the size of the undertaking. For those who appreciate their true value, there are more satisfactory and far more complete data available than could be included in such a short paper.

Departmental Budgeting In a Retail Organization

A GROUP REPORT

IN RECENT years there has been an increasing tendency toward scientific management in business. One of the outstanding examples of this new order of thought in business activity is found in the budget. "That comprehensive planning is necessary for efficient administration may be regarded as an axiom of the present-day philosophy of business administration."

Material Budget

The budget period is one of the vital factors in any budget. One business might be able to form a convenient budget period, but another business might not be able to use the same period at all. In many cases there are more than one budget period. Some stores use the regular yearly period and revise this every month. Some other organizations may find it advantageous to use a period of three months, particularly if they are engaged in business of the seasonal type. Carson, Pirie & Scott, one of the companies interviewed by this group, have three budget periods. The main budget is over a yearly period, and two other budgets are made up for six month periods and are carried along with the main budget. They also have monthly budgets, and the other two budgets are revised every month according to the results of the monthly budgets. In some cases the budget is made for one year, and at the end of each month the first month is dropped and another is added to the budget so that the expenses are always planned out a year ahead.

Sales Budget

In the installation of the budget program in any company, the following factors must first be established:

1. The extent of the budgeting program.
2. The cooperation of executives and employees.
3. The length of the budgeting period.
4. The responsibility for the preparation of the estimates.

Editor's Note: The following men collaborated their efforts to produce "Departmental Budgeting in a Retail Organization," a group report made after interviews with men involved in this particular kind of work: G. T. Korink, B. W. Laestadius, R. J. Lodeski, W. A. Malloy, L. Marcus, O. Schmidt, J. E. Schreiner, C. D. Spangler.

5. The methods of enforcing the budgets.

The most important part in the making of a budget is the estimate. If the estimate is faulty, or is drawn up by someone who is not familiar with all the facts that enter into the case, it is possible to get the estimate so far from what it should be that the entire budgeting procedure is not only impossible to execute, but is an actual hindrance to the operation of the department. The men that make out the sales budget must be thoroughly familiar with the articles being sold, the buying public, and any number of other items that pertain directly or indirectly to the sales of the department. The selection of the man to estimate the budget cannot be over-emphasized.

Labor Budget

In a large retail organization, the largest percentage of the personnel is employed in the selling operations of the store. This is shown in the following table taken from "Economics of Retailing," by P. H. Nystrom.

Typical Distribution of Occupations in a Large Department Store

	% of Total Personnel	
A. Administrative:		
1. Executive	2.3	
2. Accounting	11.5	
3. Credits and Collections	3.9	
4. Personnel	1.9	
5. Mail and Telephone	1.9	
6. Protection—watchmen	1.5	
7. Adjustments	0.8	
		23.8
B. Occupancy:		
1. Elevator Operators	1.5	
2. Mechanics	0.8	
3. Cleaners, etc.	2.7	
		5.0
C. Publicity:		
1. Advertising	1.2	
2. Display	1.5	
		2.7
D. Buying:		
1. Buyers	4.2	
2. Receiving and marking	3.9	
3. Comparison	1.9	
		10.0
E. Selling:		
1. Salespeople	38.5	
2. Cashiers and Wrappers	9.6	
3. Alterations	5.8	
4. Delivery	3.1	
5. Miscellaneous	1.5	
		58.5
Total		100.0

The labor problem becomes a serious one in a large retail organization due to the great seasonal variations in sales activity. Among department stores it is not uncommon to find the number of people employed in the height of active seasons ranging from 50 per cent to 100 per cent higher than the number employed during dull seasons.

The reports of the Bureau of the Census from the 1927 census from 11 cities studied also shows something of the variation of employees from one season to another, by the fact that the total number of employees, in all retail stores in the cities on July 1, amounted to 383,400, and on December 1 of the same year to 417,000, an increase, covering all lines of retailing, amounting to nearly 10 per cent.

Not only is there a wide variation in retail sales activity from one season

to another as indicated above, but also from one day to another during the days of the week. In an interview with one of the Wieboldt Stores' department heads, the figures were approximately as follows:

	% of Week's Total
Monday	10
Tuesday	15
Wednesday	15
Thursday	20
Friday	10
Saturday	30
	100

There is also a tendency for retail sales activity to concentrate highly during the period from 11 o'clock in the morning until 3 or 4 o'clock in the afternoon. Retail trade is usually very slack in the morning and does not reach its peak until about 11 o'clock. After the rush of midday sales, ending at 3 or 4 o'clock, retail sales slacken down to the end of the day. Studies made of this particular problem have indicated that during the period of greatest rush on the sales floors in retail stores the sales staff is usually depleted as much as 25 per cent to 35 per cent at any given time by absences for lunch.

Changes in weather, effects of holidays, and the holding of special sales, result in peaks in retail trade in some departments accompanied by an almost complete lack of interest in others. All of these variations in retail sales activity complicate the labor problem and require careful handling by the personnel department.

The solution to this problem is the labor budget. The labor, however, depends wholly on the sales budget for its preparation. Without the sales budget the construction of a labor budget for a retail organization would be practically impossible. The problem of the sales budget has been taken up in detail by one of the members of the squad so that in the following discussion it will be assumed that the sales budget has been made out and is available to the departments making out their labor budgets. When the sales budget is completed it is necessary to make an estimate of the labor required to take care of goods to be sold in the budget period. This estimate is necessary in order:

1. That the personnel department may make plans to have available the necessary salespeople at the time they are needed in selling.
2. That the treasurer may know the probable disbursements required by the labor program and can make plans to obtain funds for these disbursements.
3. That the budget committee may be able to see the financial requirements of the proposed sales program at the time they are submitted to it for consideration. The labor budget must be combined with the selling expense budget, the materials budget, and the other budgets requiring the disbursements of funds in order to show the total disbursements of the budget period, before the budget committee or the board of directors can judge the advisability of undertaking the financial obligations imposed by the proposed budget program.
4. The estimate of labor is also required in preparing the "general budget" or estimated balance sheet and statement of profit and loss.

All retail departments have a regular selling force which is employed

continually throughout the year. This regular selling force consists of 50 per cent or more of the total salespeople employed in a day on which a sale is held. The rest of the salespeople constitute the general sales force. This general sales force is usually employed about three or four days during the week. It is this general sales force which constitutes the important item in the labor budget. This item is the one which has the greatest variation and is most dependent on the sales budget.

The head of each department makes out the labor budget for his department. The estimate of labor requirements is based on past experience of the store together with plans for sales and other activities for the coming season. From past experience it is possible to determine the average number of transactions that can be handled by each salesperson and the average number of units that can be turned out by each non-selling employee. The non-selling employees mentioned here are members of the particular retail department who work as cashiers, wrappers, packers, etc. From the sales budget outlining the expectations of business it is possible to determine how many salespersons, cashiers and wrappers will be required.

For example, past records may indicate that 10 salespeople in a certain department can handle 500 transactions per day, or on an average of 50 transactions per person. If the average sale in this department is $1.50, then the average sales per salesperson is $75 per day. If the sales budget is drawn up calling for a special one-week sale for that department planned to secure a volume of sales of $1,200 per day, then it is clear that the department will require a total of 16 salespersons instead of the ten usually employed.

Number of salespeople required $= 1200/75 = 16$.

If there is any doubt that the sales plan will fully materialize, the personnel department may be authorized to provide a somewhat smaller number such as 14 salespeople. The estimate of labor required is recorded along with the other information used in determining the estimate on the following form, which assumes a budget period of 3 months:

Labor Budget							
Department	Number same period year ago	Number last period	Estimate present period	Sales last year	Sales last period	Estimate of sales present period	Distribution 1st mo. 2nd mo. 3rd mo.

This form is filled in by all departments and then sent into the personnel department, which makes out the payroll budget to cover the labor costs required by the labor budget. The completed budget is sent to the budget committee for approval. To provide the necessary control of the labor budget, a weekly report is made out by the personnel department and sent to the budget committee.

Weekly Labor Report

Department	Estimated sales	Actual sales	% Variation	% Variation last period	Estimated labor cost	Actual labor cost	% Var.	% Var. last period	Average weekly variation last period

By a study of this report the budget committee will be able to make such revisions as are necessary in the labor budget for the remainder of the period. These revisions will be sent to the personnel and retail departments for immediate application to existing plans.

Maintainance Expense Budget

From the Labor Budget we next go to the Maintainance Expense Budget. When the department head makes out his budget and brings it to the store manager for his O.K., he will submit whatever plans he may have for any improvements in his department which he believes will promote sales.

The superintendent, manager, and department head will then take up the matter together, and will consider the reasons put forth pro and con. There is, of course, no mathematical way to show that these improvements, as, for example, new fixtures, carpeting, etc., will pay for themselves. The only background with which they can compare is some previous improvement; they can see how that improvement affected the business or how the present appearance of the department corresponds to the same department in other stores.

The improvements in any department should not be proportional to the turn over. This can be shown by an example. The clothing department may have a large turnover and show a good profit entitling them to improvements. Another department may have a small turnover and show a loss. If the latter department had to show a profit in order to have improvements made, they would obviously be in a bad spot. This is true because that particular department is the one which needs the improvements in order to be put on a profit making basis. This shows that departmental improvements must be based on sound judgement rather than that they be proportional to the turnover.

When a large expenditure is made, it is not charged to that department in one single period, but is allowed to extend over several years. The general maintainance of the building, such as window-cleaning, sweeping, etc., is not charged to the departments but goes under the general expenses for the building. This figure usually remains constant from year to year.

From an interview with Mr. Green of Sears Roebuck and Company (store on Arthington St.), it was learned that all the anticipated expenses for the budget period should be listed in the budget. As an example he said he listed several filing cabinets, although at the time he did not need them. The reason for listing them was an expected increase in business. If this increase should not come, he will not ask for the cabinets, and it will be all right with the management. If, however, he did not list them, and they were needed, he would have to go to the general manager to have the order put through.

At Montgomery Ward the budget is not so flexible; if the equipment is not listed, they have to make the best of what they have. At the present time the budget is made by the officers. They give the department heads the profit they are expected to make, and they have to build everything around that figure. Of course under these conditions they must allow the departments a little leeway.

At O. W. Richardson Furniture company the budget idea has been abandoned. Mr. Tiffany, in his interview, said they had previously used quite an extended budget system. It was prepared for them by Mr. Parrish. In his method they grade the stock by age, the oldest being marked "X", the next "Y", then "Z", and the newest "A". His plans also call for several different price lines in each department. In this way they can tell which price line is most popular and they can purchase their new stock accordingly. The furniture business is quite seasonal. The budget is arranged taking this and the general outlook into consideration. Their inventory is their first approximation; the sales estimate is taken from the previous year. From the difference between the inventory for the present month and the sales for the coming month they can determine the amount required for purchasing in that coming month to keep to their budgeted inventory. They do not use any departmental expense budgeting, but budget it against the store. Under the present business condition they have abandoned the budgeting plan and are carrying as small a stock as possible. He also said the budget turned out very close. It was made flexible enough that money could be borrowed from the coming month if an exceptionally good purchase could be made at the present time. This difference would then be made up by buying less in the month from which the money was borrowed.

Abstracts of Graduate Theses

Beard, Earl Gilman, Jr., M.S. (Civil Engineering)—*The Effects of Reaction on Coagulation and Precipitation of Suspended and Colloidal Materials in Waters of Varying Turbidity.*

The limited knowledge pertaining to the value of reaction in the treatment of waters of various turbidities has heretofore been mainly theoretical. It is, therefore, the purpose of this thesis to determine by a series of tests the benefits of reaction equipment upon coagulation and precipitation of suspended materials in water of various turbidities. By establishing identical conditions for running tests both with and without reaction, a graphical comparison was derived which shows definitely the benefits of reaction.

In comparing the results obtained with and without reaction, the use of reaction brought about an additional reduction in turbidity of the sedimentary effluent of 20 to 30 per cent. This shows definitely that reaction is beneficial to plain filtration treatment. The effects of reaction upon water softening and iron removal were not investigated.

For those interested in the use of artificial turbidity, the best results were obtained when the turbidity of the treated water was about 50 parts per million. It is not necessary to create a turbidity in excess of this amount to obtain proper coagulation and precipitation.

Hollmann, Walter George (M. S., Chemical Engineering) — *Heat Transfer by Condensing Steam on Vertical Walls*

This investigation concerns the flow of heat from vapor to metal wall in

Editor's Note: The following abstracts have been prepared from the theses of the men who obtained graduate degrees from the Armour Institute of Technology at the 1934 Commencement Exercise. Each man has prepared the brief of his thesis and the detailed work may be obtained in the Institute Library.

the case of steam condensing on a vertical tube. The work is divided into two major parts. In the first part an experimental single-tube vertical condenser 6.33 ft. long made entirely of metal was used. The data obtained with this equipment was very inconsistent due to changing conditions of the tube surface. The second part of the work consists of the design and construction of a single-tube vertical glass-jacketed condenser. With this apparatus a study of the conditions necessary for either film or drop-wise condensation was made. Data were taken for both types of condensation from which steam-to-metal coefficients could be calculated. A correlation of the data with Nusselt's theory showed that the Nusselt equation gives values which are 42.15% too low for film condensation. Steam-to-metal coefficients for drop-wise condensation were found to be very high, ranging from 13,460 to 18,610 B.T.U./(hr.)(sq.ft.)(°F.).

Jacobson, Joel Martin (M.S. Civil Engineering)—*A Graphical Method for Combined Bending and Compression.*

In airplane design, weight saving is of the utmost importance. For this reason, a very precise analysis, even though involving a great deal of laborious calculation, is common practice. The most frequent problem is that of combined bending and compression. The present method of analysis, the "precise formulae," have the disadvantage of requiring long and careful arithmetic solution, especially when applied to continuous beams.

The basis of the graphical method proposed is the "conjugate point" analysis. This solution of the continuous beam problem is developed to apply to the case of combined loading which is most common in aeronautic structures, uniformly distributed lateral loads, and moment of inertia constant in each span. The airplane wing spar in biplanes is a good example. The thesis outlines the derivation of the formulas and illustrates their application to a typical problem following the customary procedure. The conjugate point method is briefly reviewed as to the operations required, its derivation not being considered necessary. Several graphical methods are available for the single span, subjected to bending and compression. One in particular has been adapted to fit the conditions of the conjugate point solution. Together with a set of tables for constants, calculated from the Niles and Newell tables for continuous beams, and nomgraphs to simplify the arithmetic, an easy and complete graphical method for continuous beams subjected to lateral and axial loading has been derived. To illustrate the application and accuracy of the method it is applied to the same problem which is used to show the customary algebraic solution.

Further study on the problem is rec-

ommended and lines of attack for some other load conditions are suggested.

Jens, Arthur Henry (F. P. E.)—*The Organization and Functions of a Fire Insurance Rating Bureau*

Many articles have appeared regarding some phase of the organization plan or of the service work offered by a fire insurance rating bureau. None of these have presented in entirety the details of the functions of such a bureau. Further the rating bureau is a public servant but has not enjoyed the publicity some of its co-organizations have received. In fact many of the individuals in daily contact with the bureau are totally ignorant of the operations of sections with which they have no contact. It is the purpose of this thesis to present with suitable diagrams the organization plan of such a rating bureau and indicate the operation of each department. A brief history of fire insurance, especially factors involved in the calculation of the fire insurance rate, transition of rating functions from insurance companies to rating bureaus, creation of a rating bureau under existing statutes and limitation of activities of the bureau are included in this work. In conclusion the author traces the results of the work of the bureau showing how the individual, the community and the state are beneficiaries of its public service policy.

Juvinall, James William (M. S. Electrical Engineering)—*A Study of the Capacitor Motor.*

Oscillograms of the current in the squirrel-cage rotor of a capacitor-type, single-phase, three-eighths horsepower induction motor were taken for various conditions of operation by applying the IR drop across a rotor bar to the oscillograph element. A special method was devised to eliminate the voltage of self-induction, which would have introduced frequency distortion. It was necessary to construct a five-tube, resistance-coupled amplifier, having a flat response characteristic down to a few cycles per second, to amplify the five-millivolt drop so that it could actuate the oscillograph vibrator. The amplitude of the component of rotor current of frequency two minus the slip times primary frequency was found to be a minimum when the angle between the stator current vectors was ninety degrees, thus indicating that this component functions as the magnetizing current for the quadrature field. This was also demonstrated analytically. The stator winding was re-designed so that the auxiliary phase furnished more of the quadrature flux, in this way eliminating some of the losses due to these high frequency rotor currents. The efficiency of the motor was thereby raised from 54% to 59%, and the cost of the condenser which was necessary to be used with the new winding was reduced by approximately two dollars.

Lange, William White (M. S. Electrical Engineering) — *Determination and Analysis of the Electrical Operating Characteristics of an X-ray Unit.*

A study is made of the electrical operating characteristics of a modern X-ray unit. Apparatus of "shock proof" design manufactured by H. G. Fischer and Company of Chicago, was used.

Oscillograms are shown, giving characteristics for a variety of conditions. Methods of analysis are developed and applied to typical cases. These analyses yield general information concerning the extent to which various factors influence characteristic operation. Consideration of the principles of operation deduced makes it possible to anticipate characteristic performance when dealing with problems of design. Experimental and calculated characteristics are compared.

Plocar, Charles John (M.S. in Mechanical Engineering — *Principles of Ventilation.*

The English language does not possess a word which conveys the same meaning that the word "Ensemble" does in the French language. Necessarily certain professions have built up or broadened the meaning of some English words to meet these requirements.

The medical profession utilizes the built up expression "Clinical Picture" to denote the component parts which present the entire picture of medical evidence necessary for a complete diagnosis.

The Heating, Ventilating and Industrial Sanitary Engineer utilizes the word "Ventilation" and endows it, in its broadest sense, to signify all the factors of heating, air conditioning, and industrial sanitation.

The problems of industrial health hazards which confront every municipality concerned with manufacturing districts are two-fold; that of the health and comfort of the employees within the plant, and that of the atmospheric conditions of the community surrounding the plant.

These are the factors with which I deal under the broadest meaning conveyed by the title of this thesis,

"Principles of Ventilation."

Ream, Altus M. (M.S., Chemical Engineering)—*Heat Transmission in a Steam Jacketed Kettle.*

The problem was to investigate heat transfer from condensing steam to water under boiling in a copper kettle with a constant overall temperature difference between steam and water maintained. A series is divided into five equal intervals between 70.5 deg. F. and 172.6 deg. F. Eighty-four series were conducted and time and condensate weights recorded for each interval. From this the heat available,

heat transferred per hour, and overall coefficients were calculated. A survey of water temperature and also wall temperature variations by means of thermocouples was conducted. Calculations of film coefficients using this data and fundamental heat transfer equations were made.

Overall coefficients increase regularly after 92 deg. F. and are greater than those to boiling water. Wall and water temperatures in different parts of the kettle are marked. The maximum energy available for imparting velocity to the water is at 130 deg. F. The steam film coefficient is lower than the water film coefficient by calculation. Steam film coefficients increase regularly with water temperatures but the water film coefficient increases very greatly at about 130 deg. F. thus proving that the available energy for imparting motion must be used.

Sandstedt, Julius (M.S., Architecture) —*Some Elements Entering into the Design of a Science Unit for a College with an Enrollment of Approximately* 500 *Students.*

Science is closely allied with the progress of modern civilization. The college laboratory or science unit is the place where many or most of the trained men who have later aided in this movement have received their scientific training. The small college will generally demand a single building in which will be housed the four root groups of science; Chemistry, Biology, Physics and Geology. While these four groups are quite different in their elementary forms, in their higher branches they are closely related. One draws upon the other for help. Modern educational methods stress this unity of science. The problem therefore becomes the design of a building in which this unity will be recognized and yet adequate division of elementary work will be provided. Tomorrow may bring a new conception in the methods of teaching science, and this must be considered. By designing on a unit system, in which this unit is the space occupied by a laboratory table, this problem can best be solved. This permits an elastic use of the building and allows laboratories to become class rooms and vice versa. A building as modern and facile as science itself will solve this problem.

Skubic, Leroy Frederick (M.S., Architecture)—*Elements in the Design of a Brewery.*

To successfully design a brewery, the architect must understand the chemistry involved in brewing, be thoroughly familiar with all existing brewery equipment, be capable of designing the plant for straight-forward processing and economical operation, and should welcome whole-heartedly the collaboration of the Brewmaster.

Due to the period of prohibition the brewing equipment of today is largely

obsolete, making necessary flexible housing structures, conducive to remodeling to admit new equipment.

The electric motor and the centrifugal pump have placed the continuous system of processing materials at least on a par with the strictly gravitational method, so that an efficient brew house may be designed containing three stories instead of from five to ten.

The author aided Arnold Spencer Wahl in designing brewing equipment using new principles, and collaborated with Sholto M. Spears in developing a new type of concrete storage tank, in an attempt to decrease present operating time and cost, and to concentrate control.

The equipment used in the package departments is thoroughly modern. For the stock house, engineers are presenting new ideas in refrigeration.

The field of brewing, again open, offers countless opportunities for enterprising chemists, engineers and architects in the modernization of the equipment and methods involved.

Spawn, Orville Jay (M.S., Chemical Engineering)—*A Modern Method of Nitration.*

The particular purpose of this investigation was to study the results obtained by reversing the flow of materials in the nitration reaction. It was believed that, if the mixed acids were placed in the nitrator and the aromatic compound was added, the process could be more easily controlled and a better yield would result than by the old method of adding the acid to the aromatic compound.

The investigation was carried out in two parts, the formation of a mononitro compound and the formation of a dinitro compound. The purification of the products of these reactions was worked out thoroughly, and marketable products were obtained in every case.

The new method proved to be satisfactory in every way, and the results showed that it was safer, cheaper, and better yields could be obtained than by the old method.

A process for the separation of nitrobenzene and dinitrobenzene was worked out during the course of the investigation, because there was no satisfactory method of separating the two before this time.

The results obtained can be easily used, with few changes, in any similar aromatic nitration and there seems to be no reason why the new process should not be used more extensively.

Terp, George William (M.S., Architecture)—*A Series of Investigations in Early Architectural Construction in the State of Illinois.*

The first investigation is to determine Illinois' most aged historic public building as an example of French tim-

ber work of the seventeenth century. The history of the building and its site, the condition at its present location, and as much of its former condition as can be determined is stated with a general plan for its possible removal and reerection in the original manner of construction.

The second investigation is that of the carpenter-architects' construction methods in northern Illinois. The house of H. J. Stouffer, built about 1850, has been measured and compared with two other houses attributed to him. A study of the available directories of Galena in 1853-1859 indicate their erection before that time and reveal the existence of an important carpenter-architect whose tools and drawing instruments are the only remaining positive records of his work. As a matter of additional interest the tools of a carpenter-architect located recently in Glencoe have been partially matched to the mouldings of two doorways known to be his work.

From these sources the general manner of construction has been evolved, placing the carpenter-architect in the light of master builder within the limitations of his day.

Vagtborg, Harold Alfred (M.S., Civil Engineering)—*The Effects of Reaction on Coagulation and Precipitation of Suspended and Colloidal Materials in Waters of Varying Turbidity.*

The purpose of this Thesis was to determine by a series of tests the benefits of the process of reaction upon the coagulation and precipitation of suspended and colloidal materials in waters of varying turbidity. The effects of reaction in water softening and iron removal were not investigated, the tests being limited to plain filtration.

By running comparative tests, first without reaction and then with reaction, and maintaining all other factors of operation at a constant, differences in the character of floc and rapidity of settling of same were noted. These differences are represented graphically and show a definite value of the use of the reaction process.

Under variations of the amounts of turbidity present the benefits of reaction continued to be in definite evidence, by continuing to reduce the turbidity of sedimentation tank effluent 20% to 30%.

It is also noted that a turbidity in excess of 50 is not necessary to obtain good floc formation by the use of reaction.

The author questions the necessity of artificial turbidity to create nuclei for floc formation, believing that a lengthened period of reaction will produce the same results without the use of artificial turbidity.

The Duties of a Local Agent

By EARLE H. SHAW

THOUGH the qualifications of a good agent are the same here as in other countries, the society is differently constituted, so that greater scope is given for the agency business. In the cities and larger towns it can be made a profession, while in smaller towns and communities a farmer, merchant, professor, county officer, attorney, or physician can add materially to his income by spending his leisure hours in the interest of a first class insurance company.

As most people insure on the strength of an agent's representations, trusting him implicitly, he should be thoroughly informed as to the character, condition, and general advantages possessed by the company he represents.

There is probably no occupation in the world in which it is so necessary to combat with the caprices of mankind and deal with humanity in such various phases as in the agency business. General, State, Special, and Local Agents alike all have these problems to contend with. This portion of the paper, however, is written with the intended purpose of dealing with the duties and responsibilities of Local Agents only, and should not be misconstrued to cover the workings of other agents, although they will not differ to a great extent.

It is a known fact that the Local Agent is the paramount factor in securing business for the company, and since the major portion of fire insurance written for the companies in this country comes to them through the Local Agent, situated in various cities and towns, it is most essential the companies use extreme care in the selection of their local representatives.

The Local Agent assumes tremendous responsibilities, and therefore should have ability to or exceeding home office requirements. It should be his aim to serve the interests of the company with both fidelity and ability and still be equally loyal to his clients.

Ketchum and Kirk in their book, Essentials of Fire Insurance Business (p. 171) give a brief summary of the authority invested in an agency. "The local agent is authorized by each company in his agency to represent the company in the city and vicinity in which he does his business; his duties are to solicit business for the company

Editor's Note: Earle H. Shaw, a Fire Protection Engineer of the class of 1934, has written this article from the experience derived thru his work with men in the fire insurance field during his years at the Institute.

and to contersign policies; (to look after) and on demand from either the assured or the company to cancel policies, also to increase or decrease the amount of insurance on policies already in force; to affix riders to cover increase of hazards; to assign policies; to look after the mortgage interest in policies; to collect premiums and remit each month to the companies; to issue lost policy receipts; to issue binders on rare occasions; to view and inspect risks to be insured; to form a close estimate of the appraisals of the building and possibly of its contents; to know the financial conditions of the people of his territory; to judge closely the moral hazards and the character of the men and women seeking insurance."

When the agent has received his supplies and opened his office, the idea uppermost in his mind naturally is to secure business for the company. This is entirely as it should be, but a greater number of agents in their anxiety to write a large volume, often forget, or it is permissible to say overlook, the fact that the company's interest must be served in the selection of the risks. They find in soliciting it is comparatively easy to obtain business on certain classes and in certain sections of their town. They also find these risks carry a very high rate which quickly establishes a large premium income

This condition usually has to be contended with in all new agencies when the solicitor or the agent has had very little if any previous knowledge of the insurance business. In such cases of course the company should closely supervise and investigate all of the business written. They should also impress upon the agent the fact that he is invested with the authority to accept risks as he sees fit, bearing in his mind always that the interests of the company he represents are in his hands and must be protected the same as if he owned the company himself.

As his business grows the agent will find it is often necessary to issue binders on certain properties, as complete information for issuing the policy is not always available when needed. Although this practice is not to be condemned, it should be avoided whenever possible as occasions often occur when serious complications arise, and no doubt prove very embarrassing to everyone concerned.

Since, however, binders are absolutely necessary in the course of the agent's business, he must use a great deal of care and discretion in issuing them on properties and clients with whom he is not very familiar. He should always remember that binders are often secured by some people as a means of collecting insurance on properties that are mostly uninsurable.

Losses of this character, although very rare, contribute many thousands of dollars to the loss ratio of the country each year, as the companies are compelled to pay in the majority of cases.

There are also many cases where the companies have been forced to pay

claims to parties who having applied to an agent for insurance, and the agent, by not admitting or denying that the policy would be issued, has led them to believe they were fully protected.

The blame for such situations is assigned to the agent for neither refusing to accept the risk or issuing a binder or policy immediately. Consequently every agent should remember his actions are the actions of the company, also his knowledge is the knowledge of the company and therefore should be so regulated as to protect their interests.

This power the company does confer on an agent to countersign policies is often overlooked by him as being of minor importance, whereas if he stopped to analyze the situation he would no doubt realize that any policy not bearing a legal signature is nothing more than a forgery, thereby making the contract null and void.

The comments on this particular duty of an agent are written here since the courts have held that an agent cannot delegate his authority to a clerk of whom the company has no knowledge.

One of the agent's weightiest responsibilities is to collect the premium on all policies written, and remit the company at the time the balance is due. The collecting of premiums may appear to some as not a very great responsibility to the company, but mostly the agent's responsibility to himself. In order to justify the statement that the responsibility to the company is just as great it might be well to give a fair example of what happens to both the company and the agent when a premium past due is not collected.

A premium of one hundred dollars is due on property owned by John Doe. The collector calls the first time and is promised payment in thirty days. The second and third calls he again receives the same promise, and so on until the amount is past due five or six months. By this time the agent becomes worried and uses every means possible to get the money. In some cases he is successful, in others cancellation is the only salvation and even then the agent is compelled to pay one or two months earned premium himself.

The above is a practice only used by dishonest assureds who hold policies with no intention of paying for them as long as the agent will let them, and then cancelling them flat and seeking the protection of other companies or other agencies, continuing this procedure as long as they can get away with it. This evil can be almost entirely eliminated by the agent if he will make a practice of writing up the expiring policies in advance and take prompt action to make certain that the policies will be accepted.

In other words, a few risks promptly settled are better than a large amount of business carried at the cancellation point, and the agent should remember one of the most important services he can render his community and also himself is to keep out of debt.

As an example of what will always

occur when an agent neglects to carry out the instructions of the company, we will say; a certain agent issued a policy and on the next day after it was reported, the company instructed them to cancel and return it, which they neglected to do. A month later the property was destroyed and the company paid a compromise settlement with the assured. The company then entered suit to recover from the agent the loss paid, and of course the court held that the agent having been guilty of negligence in failing to obey the instructions to cancel the policy, which resulted in the loss, was liable to the company for the amount paid the assured.

"In Wolf's Law of Insurance the court held that the agent was liable to the company for the loss occurring through his delay in not cancelling the policy in accordance with its instructions." Such a decision having been handed down by the U. S. Supreme Court should impress upon the agent the importance of relieving the company of liability immediately when requested.

Other responsibilities that should be explained at this time are endorsing policies, increasing or decreasing amounts of liability of risks, and attaching riders to cover increase of hazard. The execution of these factors are in some instances more important than writing new business or cancelling policies, as the agent usually has on hand more evidence on which to base his opinion of a risk.

Should the company instruct the agent to procure a reduction in the amount insured by a policy issued by them, the same immediate action should be given by the agent as when a policy is requested cancelled. The agent should advise the company that the reduction has been effected and replace or cancel the amount immediately, as in case of loss the company would be entitled to collect from him the difference between the amount of insurance paid and that which should have been paid had the insurance been reduced as directed.

Whenever an agent receives notification of an increase in hazard of any risk he should notify the company immediately by endorsing the policy. He should remember that on some risks where the hazard has been increased the company might not desire to continue the policy and since the policy will continue in force until requested otherwise, it is necessary that they be notified as promptly as possible whenever there is change in the risk.

Any agent with a working knowledge of the insurance business will understand that the physical hazard of any risk may be increased in a few hours' time. It is therefore essential that on risks where the chances are great for an increase in hazard the agent should impress upon the assureds the importance of notifying him immediately whenever such change takes place.

The best procedure for the agent to

follow after receiving notice of a loss is to advise the company immediately and await the arrival of the adjuster before visiting the risk. By so doing all questions will be answered by the adjuster and the burden of responsibility passed on to him.

The following pages will present the general system and accounting methods employed in a typical insurance agency.

In order to make the system more clearly understood it will be necessary to explain the use of the more important forms employed in the fire insurance department of the agency. This department will be discussed because it is of the most interest to those who read this paper.

An individual line card is in the form of a folder and contains all fire and tornado (reports) policies for the same assured. Complete copies of the daily reports represented by these policies are filed in the line card in alphabetical order according to the name of the assured.

The order blank is the form for all fire, tornado, and side line business.

The charge memorandum is the method of charging premiums to the customer's account, and is printed in triplicate. The white copy serves as a charge memorandum, the blue copy is filed according to month and year and used as an expiration record, while the buff copy is filed by the company and policy number to be a source of information when needed.

The credit memorandum is used for the purpose of crediting all return premium items to the accounts of individual customer and broker.

The endorsement order is used for recording information for indorsing policies regardless of the nature of the change in policy required by the endorsement. It is prepared in duplicate, the original going to the policy department, and finally is pasted in the line card. The second copy is held by the line clerk who audits all such details work, until the first copy is returned to his desk.

The binding notice is used to notify the company when it is bound by an insurance policy and there are reasons why the poilcy cannot be prepared in the regular course. It is prepared in duplicate, the original going to the company, and the copy is held in a special file until the same is closed and the policy written.

The location card is an invaluable record, especially when information is required promptly regarding any line of insurance and the location of the property alone is known.

The premium statement is a record of all new and renewal business daily as well as the total for the month to date.

The memoranda of policy is a form prepared by the policy clerk in all instances where there is a mortgage clause applying to the individal policies.

Each department contains as many employees as are needed to properly carry out the work. In the case to be

studied there are four employees in the fire and side lines policy department. The first clerk writes the policies and attends to the details involved applying to new business. The second clerk is designated to write renewal policies and take care of resulting details. The third clerk prepares all endorsements and takes care of cancellations. The auditor checks all policies and resulting detail work, and besides taking care of the statistical work he also serves as assistant to the office manager.

Orders for new business originate with the production department, and are prepared in duplicate. Both copies go to the desk of the office manager who designates the company that is bound. The first copy goes to the engineering department. The property is inspected and appraised, the rate analyzed and the result shown on the order. The second copy goes to the desk of the auditor who checks the policy. He destroys the copy after making sure the original has been returned to the office manager for any special treatment which may be necessary. The original passes on to the "new policy clerk" who computes the premium, prepares the policy, charge slip, invoice, line card, makes location entry, and finally the original order is pasted to the line card. After completion of all detail work the completed policy is mailed or presented personally by the agent to the insured.

On the 15th of each month the expiration memoranda of the second succeeding month is taken from the file and compared with the corresponding line card. A transcript of all policies is prepared according to expiration dates and sent to the auditor's desk as a check on all renewals, and aids in determining the percentage of business not renewed. Identification memorandums go to each department where the property is inspected, valuations are checked and rates dissected. Renewals are analyzed by the office manager, then sent to be prepared by a clerk, after which the auditor gives them the same attention as new business.

When an order is taken for endorsing a policy the original order is matched with the line card and the duplicate is sent immediately to the desk of the auditor and held as a check on possible delays until the completed endorsement is received by him. Then the duplicate order is destroyed. The original is sent together with the line card to the clerk who is specially delegated for this class of work. Endorsements are prepared in triplicate, one copy for the company, one for the office daily reports, the original order for endorsement pasted in the line card. Such detail is completed by the proper clerk, after which the endorsement and the line card are then sent to the auditor's desk and finally to the desk of the proper employee for transmission to the assured.

We will now consider the bookkeeping and cashier's department. The ledgers are prepared open tray files, arranged so that the sheets can be

readily taken from the ledger and placed in the bookkeeping machine for posting. There are *four* general controlling accounts: the general ledger comprising the accounts representing income and disbursements, assets and liabilities; the accounts receivable represent all customer's and broker's accounts; the accounts payable are represented by net monthly balances owing the company and all other accounts other than those which are current, are remitted by voucher, which gives a complete record of such items, and obviates the necessity of passing such accounts through the ledger, and the loss claims amounts represent those loss claims which the agency has paid or advanced for the companies. Each of the above are balanced independently at the close of the month's business.

All minor expenditures such as expressage, etc., which require payment at the office are paid through a petty cash account. In the voucher system entries of the items on the check register for posting to the ledger accounts are made on duplicate voucher checks. Each voucher contains sufficient information regarding expenditures to identify the accounts to which it is to be charged. The duplicate serves to check and balance the bank account at the end of each month.

The check register is a loose leaf record on which vouchers are entered in numerical order. Vouchers are charged individually to the affected amounts, credited to the bank on which they are drawn, and the totals of the column (for keeping daily account) are posted to the proper controlling accounts in the general ledger at the end of the month. At the right is a column for keeping daily account of the bank balances showing total amount in the bank at the end of each day.

There is a loose leaf record which serves as a cash receipts journal as well as for entries affecting the various accounts. There is a cash column and a column for the several controlling accounts.

All currency and receipts are deposited in the bank and are not confused with the petty cash fund. At the end of each month all receipts and disbursement are credited or debited to the respective bank accounts on the ledger. All voucher checks returned by the bank are checked with the duplicate. A special form is used for company monthly accounts current to companies, and debit and credit memoranda are arranged according to companies and listed according to monthly accounts. The premiums are shown first, return premiums next, and net premiums extended. The fire and wind storm premiums are listed separately.

The net balances are extended on all individual accounts in the ledgers as postings are made. After the accounts have been balanced for the month, balance statements are prepared which show the assets and liabilities as well as net results for the month and period of the year represented.

THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Basketball

On Thursday, November 1, Coach Kraft issued the first call for varsity basketball. A large crowd, of which many were freshmen, responded. Al Lauchiskis is this year's captain. His likeable personality is proving to be a great asset to the team. There were only three men lost to the squad by graduation last June, namely, Lukas, Pflum, and Rummel. These men were all valuable to the squad, especially Pflum and Lukas, who held regular positions.

This year five major lettermen and one minor letterman are back. The varsity is in good shape, but there is plenty of room for improvement. None of the men are sure of their jobs, as there is always plenty of reserve material ready to give the regulars a battle.

Manager Humiston has scheduled five games to be played before the Christmas holidays. They are:

December 6—Chicago Junior College at Armour.

December 11—George Williams at Armour.

December 15—University of Chicago at Chicago.

December 18—Wheaton College at Armour.

December 20—Lake Forest.

Track

Coach A. A. Stagg, Jr., is looking forward to a successful track season this year. He is urging the men to come out for the team, as he must have new material. Practice is held at the University of Chicago fieldhouse. All new men interested in this sport should turn out as there are plenty of openings.

Last year was successful and it is hoped that this year the indoor season will be even better. Practice will start in the very near future.

Swimming

The swimming team is practicing at Bartlett pool on the Midway, under the guidance of Coach McGillivray. There is a need for some good high divers and sprint men. There is always room for good material in all departments. Any men who are interested in swimming should see John Ahern, who will give them further information concerning the team.

Interclass Athletics

The juniors, having a well-organized team, succeeded in defeating all opposition to win the interclass baseball tournament. The able pitching of Harry Dollenmaier was the main cause of the team's victories. The seniors were the first to fall victim to

the juniors, while the sophomores succeeded in downing the freshmen. After a hard-fought game the sophs were nosed out by the juniors with one run in the last inning.

The green freshmen did not look so green when they emerged victorious in the interclass basketball tournament. The sophomores, after giving them a scare in the first half, fell victim of a sudden rally later in the game. The juniors meanwhile downed the seniors to advance to the finals. In the final game the juniors went down before the fast freshmen team. The frosh just could not be beat. The freshmen found the basket frequently in the final game, while the juniors, who looked so good against the seniors, were not able to make their shots click.

Tau Beta Pi

Public pledging of eleven men, including one junior and an alumnus, to Tau Beta Pi, honorary engineering fraternity, took place at the all-engineering society assembly October 26. The pledges were introduced to the student body by Professor Sholto M. Spears, a member of Illinois Beta's advisory board. The undergraduates honored at this time were:

Louis W. Biegler, '35
Joseph H. DeBoo, '35
Otto P. Freilinger, '35
John F. Humiston, '35
John O. Larson, '36
John K. Morrison , '35
George A. Nelson, '35
Joseph M. O'Connor, '35
William A. Trudelle, '35
Howard J. Zibble, '35

In addition to the ten undergraduates, Mr. D. C. Witt, an Armour alumnus of the class of 1934 and at present director of research for the Universal Atlas Cement Company, was also publicly pledged.

Election of officers of the local chapter took place last May. The men elected to guide the chapter for the present year are:

Richard D. Armsbury, president.
John J. Ahern, vice-president.
Edwin N. Searl, corresponding secretary.
William B. Ahern, recording secretary.
Albert E. Lauchiskis, cataloguer.

Richard D. Armsbury, as a delegate from Illinois Beta, attended the national convention of the organization, held this year in New York City. Sixty-five chapters of Tau Beta Pi were represented at the three-day meeting.

Phi Lambda Upsilon

The following men are the present officers:

President.....Al Lauchiskis
Vice-President..C. H. Riesz
Secretary.....R. C. Miller
Treasurer....J. N. Weiland

These men were elected to their re-

spective offices last spring and will continue to serve throughout the coming year.

Numerous meetings were held during the month of October in preparation for the annual pledging. That event took place during the evening of Thursday, November 1, in the Tau Beta Pi rooms. The men honored by pledgeship were:

J. Kahles
J. H. Johnsen
H. P. Milleville
R. M. Paulsen
O. Zmeskel

All of these men are juniors in the department of chemical engineering.

Immediately after their pledging the new men took an active part in the affairs of the chapter. They have now practically completed plans for a smoker to be held in the near future.

Chi Epsilon

The local chapter initiated Joseph M. O'Connor, C.E. '35, October 25, in the Chi Epsilon rooms in Chapin Hall. The ceremony, which was well attended by faculty and alumni members, was followed by a dinner in the faculty grill. Afterward, several members attended a meeting of the junior section of W. S. E., at which Gordon Fox of the Freyn Engineering Co. gave an illustrated lecture on "Russia."

Officers, elected after the initiation, are as follows:

President.....George A. Nelson
Vice-Pres...Kenneth O. Stocking
Secretary...Joseph M. O'Connor
Treasurer.....Prof. H. T. Heald

The new pledges, selected from the outstanding members of the Junior and Senior Civil classes, were announced recently.

Chi Epsilon also announces the addition of two new chapters. Charters were granted to the respective petitioning groups of the Universities of Texas and Missouri just before the close of school last June.

Pi Tau Sigma

Armour Delta chapter of the honorary mechanical engineering fraternity elected the following officers at a meeting last May:

President.....W. W. Henning
Vice-President.....J. H. DeBoo
Corr. Secretary..B. L. Messinger
Rec. Secretary.....M. J. Fotter
Cataloguer.....A. Christoph

At a recent meeting, J. H. DeBoo was elected delegate to the national Pi Tau Sigma convention to be held at the University of Wisconsin, Madison, Wisconsin, on November 23 and 24.

Salamander

Salamander, honorary fire protection engineering fraternity, pledged four seniors and one junior at a meeting of the society in its rooms October 19. The men thus honored were:

Curtis R. Bristol, '35
Lester Kerlin, '35
Raymond A. Peterson, '36
William A. Trudelle, '35
Howard J. Zibble, '35

Previous to the pledging, Otto P. Freilinger was elected pledge captain. The pledges cooperated in making the all-

engineering society assembly a success by preparing posters to advertise the event.

Near the close of the last school year, on May 22, election of officers was held with the following results:

John J. Ahern, president.

Louis W. Biegler, vice-president.

Edwin N. Searl, secretary.

George W. Wheaton, treasurer.

Otto P. Freilinger and John K. Morrison, co-editors of the "Deflector."

Sphinx

Ten men active on Armour publications were pledged to Sphinx, honorary literary society, October 30, at a meeting held in the Beta Psi house. Of the men, six were seniors and four were juniors. The wearers of the yellow and black ribbons are:

Jacob M. Bard, '35
Curtis R. Bristol, '35
Otto P. Freilinger, '35
John F. Humiston, '35
John K. Morrison, '35
Robert J. White ,'35
Frank D. Cotterman, '36
Russell R. Johnson, '36
Roy S. Kercher, '36
Harry S. Nachman, '36

Officers of Sphinx, elected last semester, are Howard J. Zibble, president, and Leroy J. Beckman, secretary-treasurer.

Alpha Chi Sigma

Alpha Chi Sigma, professional chemical fraternity, began the season with the installation of the following officers:

Master Alchemist.....R. M. Paulsen
Vice Master Alchemist L. W. Robbie
Reporter.....A. J. Ragan
Treasurer.....A. Rulis
Alumni Secretary....J. J. Doheny, Jr.

The committee has been working for some time making preparations for the smoker, and their efforts were fully rewarded on November 14, when the event was held. A large percentage of the members enjoyed the good program that had been arranged.

The following men recently entered into pledgeship:

J. H. Johnsen, '36
H. P. Milleville, '36
R. C. Peterson, '36

The Western Society of Engineers

THE Armour branch of the Western Society of Engineers last May selected the following officers to guide its activities during the coming year.

President .....George A. Nelson
Vice President..Kenneth O. Stocking
Secretary.....Joseph M. O'Connor
Treasurer .....Chedo P. Grakavac
Student Representative.Bruno Rigoni

The officers are planning an interesting program of talks by outstanding men of the engineering profession. Thus far they have presented Charles C. Whittier, president of W.S.E., who spoke before the entire school on "The Engineer of the Future," and Charles A. Morse, formerly chief engineer of the Rock Island Railroad, who gave an informal talk on his experiences as an engineer.

An intensive membership drive has

received the wholehearted support of the civil engineering department, the lower classmen being particularly active. The ultimate aim of the society, however, is to interest all engineering students, and a good start in this direction is evidenced by the membership of several men of other departments.

American Institute of Chemical Engineers

The present officers of the organization are:

President.....J. N. Weiland
Vice-President..R. C. Miller
Secretary.....C. H. Reisz
Treasurer...J. F. Humiston

These men were elected to office last semester.

On October 11, a joint meeting was held with the Chicago Section. A dinner in the Faculty Grill preceded the meeting. The speaker of the evening was Mr. H. J. Brownlee, technical director in the Cedar Rapids, Iowa, plant of the Quaker Oats Company. Mr. Brownlee's subject was "Chemical Engineering Technology in the Manufacture of Furfural." After the meeting a number of the members of the Chicago Section made a tour of the Armour laboratories.

A survey is being made of the members in order to determine their preference of subjects for discussion at meetings. As soon as the data can be compiled for this purpose, it is planned to take up the subjects in the order of decreasing interest. It is expected that for each meeting an excellent speaker will be secured to present the subject to the group.

Fire Protection Engineering Society

Conditions at the Chicago stock yards, previous to, during, and after last May's $6,000,000 conflagration, was the subject of the talk by Mr. J. A. Neale, chief engineer of the Chicago Board of Underwriters at the first meeting of the Fire Protection Engineering Society for the current year. Mr. Neale investigated conditions at the yards on behalf of the Chicago Board both before and after the disaster and was, therefore, in position to relate a very complete account.

The speaker pointed out that while the radio description of the fire was very exaggerated and inaccurate, it performed great services for the fire-fighting army by causing out-of-town equipment to be sent in to protect areas left unguarded by the emergency, by informing off-shift members of the Chicago fire department that their services were in demand, and by urging conservation of the water supply by the general public.

The splendid record of the mechanical equipment of the department, which did not suffer mechanical defect of any sort in any instance, was pointed out by Mr. Neale as a result of the work of the maintenance department.

The F. P. E. S. cooperated with the other engineering societies in sponsoring the all-engineering society assembly held October 26th.

THE ARMOUR ENGINEER

Student Technical Publication of Armour Institute of Technology

VOLUME XXVI | NOVEMBER, 1934 | NUMBER 1

Twenty-sixth Anniversary

THIS marks the twenty-sixth year since the founding of the Armour Engineer. In that time the magazine has changed from a small catalogue to one of the better recognized engineering quarterlies in collegiate circles.

Several changes of note have been made in this volume. It is the policy of the staff to cater to the student body. With this in mind, the humor section has been increased, we sincerely hope, not only in size but in humor. The cover will from time to time depict various processes in the steel industry.

Any suggestions which will improve the book are always welcomed by staff members.

THE GUEST EDITORIAL

Professional Development After Graduation

A GREAT deal has been said about improving the professional status of the engineer. Various plans have been proposed for making engineers more useful citizens and at the same time according them a degree of recognition more nearly on a par with that of other professions. Many of these suggestions involve changes in our methods of engineering education. Much can probably be accomplished without any basic adjustment in the conventional four-year curricula if engineering graduates can be made to realize that the educational process is not terminated with the award of the diploma.

Today, an increasing number of engineers are taking one or more years of graduate work, but while this is in many cases desirable, it is probable that the majority of men entering the profession for many years to come will have no more than four years of college education. To these men, the best means of increasing their usefulness and raising the standards of the profession seems to be in the pursuance of a systematic plan of personal development and education *after* graduation. Certain of the national engineering societies, working through the Engineers Council for Professional Development, are preparing detailed plans for the development of the younger members. In Chicago, the Western Society of Engineers is formulating a similar program.

Recognizing the fact that the first few years of his professional life may exert a profound influence on his ultimate accomplishment, serious efforts are to be made by the older members of the profession to assist the young engineer to establish habits of study and of thought, and to develop friendships and a mode of life which will pave the way for sound achievement. If these efforts are to be successful, engineering graduates must enter into them whole-heartedly. The years immediately following graduation usually have relative freedom from social and family obligations as compared with later life, while professional duties are often somewhat routine and may be lacking in intellectual stimulation. Wisely invested, this is time that will pay real dividends.

The young engineer who starts to build his career in Chicago has unexcelled opportunities to lay the foundation for real accomplishment. The engineering societies, the formal educational institutions, and many fine libraries provide ample facilities for development in almost any field. No man with a sincere desire to succeed can afford to neglect these opportunities.

HENRY TOWNLEY HEALD
Dean

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

Applied Kinematics

By J. Harland Billings
Van Nostrand Company

THE fundamental principles upon which the study of kinematics is based have not suffered any great change for many years, but this has not been true of its applications. The importance of some, such as speed in machines, has increased, while others have become of less consequence. In this book, therefore, the author has attempted to give the fundamentals of kinematics as applied to modern machines.

Intended for both the student of engineering and the mechanical designer, the book includes in the first few chapters a study of the theory of simple mechanisms, together with the determination of velocities and accelerations in them. Three different graphical methods are given for the solution of velocity problems, and general methods are stressed more than those which are applicable to only one particular mechanism.

Various types of cams and their designs; gears and the methods of machining them; gear trains as applied to automobile transmissions and radial engines; and flexible connectors, such as belt, rope, and chain drives, are described in later chapters. Included in the volume is a section devoted to the theory of several familiar mechanisms, such as the universal joint, the differential gear, the Geneva stop, and the motion picture projection machine.

The book contains an abundance of cuts and drawings, and problems for solution on paper or in the drafting room are also given.

Internal Combustion Engines

By V. L. Maleev
McGraw-Hill Book Co.

MOST books on the subject of internal combustion engines fall, as far as the treatment of the material goes, into one of three categories—theory alone, design alone, or description alone. The author of this book, however, has written one which is, in a way, a combination of all three, for the volume includes not only descriptions of engines and their design, but the fundamentals behind them. It is intended for use both as a college text-

book and as a work of reference for designers of internal combustion engines.

Although a knowledge of engineering mechanics and thermo-dynamics is presupposed, a chapter is devoted to a review of the most important and useful parts of the latter subject. Most of the formulas relating to thermodynamics are derived from more well-known equations in the text.

Included in the book are discussions relating to the theoretical and ideal cycles of internal combustion engines, the actual cycles and the reasons for the difference, four-stroke combustion and explosion engines, two-stroke engines, and engine efficiencies. The volume also contains information on fuel and its combustion, various types of cooling systems, and lubrication. The data and theory necessary for the design of the various parts of gas and oil engines, such as the frame, crankshaft, running gear, etc., constitute a large part of the book, and a chapter is devoted to the rating and testing of finished engines. The large number of illustrative examples which occur help materially in the study of the text, which contains numerous illustrations.

Industrial Chemistry

By W. T. Read
John Wiley & Sons

In this book Mr. Read gives us a picture of the ways in which chemistry enters into modern industry, and how the various raw materials are secured and changed into useful products. Students of chemical engineering will find it a volume of especial interest, inasmuch as it gives them a broad view of the field that they are entering. Likewise, teachers of chemistry in college or high schools will be able to make use of the material it contains, as will students and business men, who are often in need of condensed information relating to some specific process or product.

The first few chapters in the book deal with the subject in general and include a discussion of the various chemical organizations, sources of information for chemists and chemical engineers, chemical economics, and the like. The remainder of the volume is devoted mainly to the various products into which chemistry enters. Sources of raw materials and the manufacture of such substances as rubber, explosives, paints, varnishes, and petroleum products are described from the standpoint of chemistry, and the preparation of the various compounds of sodium, calcium, magnesium, silicates, sulphur, etc., are discussed in detail.

In order to gain other viewpoints and assure the correctness of his work, the author submitted every chapter in the book to authorities in their respective fields. The illustrations in the text are, for the most part, drawings of apparatus or processes contributed by industrial concerns.

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF THE AUTHORS AND PUBLISHERS

Disposal of Refining Waste Waters

By W. B. Hart

(From Industrial and Engineering Chemistry, Sept., 1934)

UNTIL recently little attention has been paid to the disposal of industrial wastes, for plants and factories were scattered and this problem was simple as it caused no harm or annoyance to anybody. When rapid growth of industry took place and industrial establishments were concentrated around population centers, the problem of waste disposal grew into its present form.

In the scramble to enter attractive markets, little thought was given to anything but the quantity of the product, the design of the process, equipment, and the starting of operations. Towns and cities had grown, and the sewage pollution occurred when the wastes were dumped into the drainage system.

Petroleum refining has grown rapidly during the last 30 years. The first oil well was drilled in 1859 and yielded 2,000 barrels of crude oil for that year. In 1900 production had reached 64 million barrels, and in 1929, over one billion barrels of crude oil were brought to the surface. This increase is due to the development of the motor car, the internal combustion engine, and the use of fuel oil.

Prior to 1900, gasoline was a waste, now it is a major product. Originally all crude oil was of the Pennsylvania grade which could be purified by simple processes. Later, the Mid-continent, Texas, and the California crude oil appeared which created new problems in purification. These new problems created to produce wastes which presented real problems in disposal.

Gases, liquids, and solids occur as wastes in present day oil-refining. Gases and vapors generated by distillation, acid treatment, sludge separation, etc., are hydrocarbons of low boiling point or sulphur dioxide or trioxide. Such gases will diffuse to an unnoticeable concentration in very little time, but other gases such as the marcaptans, and other sulphur organic compounds, possess a very disagreeable odor even in low concentrations. Complaints of air pollution are due to these compounds.

A major refinery waste is oil, which may vary from gasoline to heavy lubricants. It originates anywhere in the plant due to leakage, or may be discarded for various reasons, such as being emulsified or contaminated.

Refineries use large quantities of water, which is discarded as waste. Water for cooling purposes is not impaired. When water is used for washing purposes, small quantities of alkalies, acids, organic sulphur compounds, or phenols are dissolved. These give the water an objectionable taste.

Waxes, asphalts, sludges, clags, and general rubbish make up the waste products.

Research work on the elimination of oil from water produced oil separators. This equipment operates on the specific gravity differentials of the water they discharge and the oil they retain. Methods of breaking up these emulsions were studied. The method varies with the topic of emulsion; in some cases heat is required, while in other cases a charge in pH followed by a floc clarification of the water is necessary. It was found that the separators operated best when velocities were low and eddy currents were absent.

Air pollution was eliminated by the use of scrubbing towers and similar closed systems.

Water pollution, the most difficult problem, was solved by putting one waste against another waste of opposite polarity. Excessive alkalinity was corrected by letting it react with an acidic waste. If further neutralization was required, the cheapest desireable agent was added. This may be lime, limestone, soda ash, or dilute sulphanic acid. In all cases, the situation must be studied so that the proposed treatment will not introduce another objectionable waste.

In controlling the reaction of the waste water the plant should be on the lookout for "high total solids." In no case should the effluent water contain more solid matter than 1000 parts per million.

Tastes and odors can be traced to two sources—sulphur organic compounds and phenols. Both are formed from the same general sources, waste caustic solutions. The segregation and treatment of these solutions will greatly reduce odors and taste. Many chemical methods are used for treating the caustic wastes, some returning valuable by-products.

Common Sense in Transportation

(From Roads and Streets, Oct., 1934)

WE HAVE several times used that phrase "Competition will eventually make over our railroads into a cheaper and far more efficient transportation machine." We are convinced that such modernization will be the eventual solution of our transportation problem. Government regulation, attempted coordination, railway czars, programs for the strangulation of competition may retard the process, but cannot successfully withstand the economic pressure.

Railway developement has followed natural lines, although the evolution has not been rapid enough to satisfy congress, nor the shipping public, for that matter. Having somewhat over-

built a system sufficiently superior to drive practically all competition from inland waterways and highways, the railways proceeded to produce abuses inherent in a nation-wide monopoly. Government regulation followed. Resisted by the railways at first, it was later accepted as a comfortable shelter behind which standard schedules and an interlocked fabric of fares, rates, and schedules was constructed, supposedly designed to produce maximum earnings with a minimum of effort.

The carriers did not recognize it, but this static state was rather the first stage of senility. The traveler who remarked that the only innovation introduced by the railways in two generations was a slot for the razor blades in Pullman washrooms had some basis for his criticism. At any rate, commerce resented the attempt to restrict its markets, and the old forms of competition by highway and waterway returned with new vigor and vastly improved equipment. Railway response was the cry of the defeatist—"Regulate our competitors." But public support has not been forthcoming. Neither highway nor waterway transportation has any record of railway regulation.

But a minority of railways preferred action to inaction, and their plans to do something about it by "making over" their facilities are commencing to materialize. As usual, the first steps were directed toward a rejuvenation of passenger service, and air conditioned trains made their appearance. Added comforts, however, would not attract the bus rider or the motorist, so lines in the south and southwest sharply reduced passenger fares. The development of lightweight, streamlined motor driven trains or single units to cut operating costs was a natural consequence. Revolutionary changes in freight service charges were initiated. Door to door service was offered. The speed of the freight trains was increased, and the latest proposal is to clear away the intricate and troublesome freight classification with its archaic distinctions and offer equal door to door service for anything the public may wish to ship.

The future is beginning to clear, and our legislators at the next session of congress should hesitate before offering comfort or support to any bill involving the extension of regulation coordination, public operation, or what not. Not only transportation, but the restoration of commerce, and with it prosperity, are at stake.

Winning Customer Attention by Showmanship

By L. G. B. Pitby

(From Commerce, Oct. 1934)

USE OF entertainment features to wrap up a selling lesson is a striking trend of present advertising. The problem of this form of presentation is the proportion of pure entertainment to selling argument.

At the 1934 World's fair this problem was attacked from both ends. One heard great symphony orchestras free, in connection with which only a modest

mention of the name of the exhibitor giving this lofty and costly entertainment was made. At the other extreme one saw shows which were almost purely educational as to the exhibitor's product.

Forty-seven corporations, companies sales organizations, laboratories, and others used films to put over their stories in 1934. More than 60 projections were used, most of them 16 min. Exhibitors usually coated their advertising with liberal entertainment.

Chrysler, Ford, General Motors, Goodyear, Rhode Island Lines, Studebaker, and the Inland Waterways used 35 min. films requiring union operators and two projectors. There were also individual types of exhibits such as the microvivarium, which combines the microscope with lines. This shows minute life cast upon a screen magnified hundreds of times.

The World's Fair proved definitely that the eye and ear are now being recognized to a greater extent than ever before as of major importance both in selling and in education.

Scientific miracle shows had an appropriate setting in the World's Fair. The General Electric Co's. "House of Magic" was presented 24 times a day. There was no mention of the corporation sponsoring the liquid air experiments of the Union Carbon and Carbide Corporation, but folders were handed out after the exhibition. The Electric Light and Power Industry and the Kelvinator corporation presented marionette shows. The Leonard Refrigerator Co. employed a well-known sleight-of-hand artist. The Westinghouse Co. employed an actress who held the stage in silent pantomime in six scenes given on a revolving set. Sears Roebuck and Co. showed the operation of their testing laboratories and other educational subjects.

Ford gave ten forty-five minute shows a day which included comedy. General Motors had twelve different films lasting three hours. Features of different products were emphasized with continuous stress on the sales points.

The Chrysler air cooled theater had a continuous show. This included the regular Pathe news reel, changed twice a week. Spectacular tests of the durability of cars included the bouncing of one off a rocky cliff. Studebaker had a theater built in a form of a gigantic automobile. The show consisted of a straight selling demonstration, illustrated by scenes of automobile racing, hill climbing contests and the rolling of cars down the rocky sides of a quarry.

A tight wire act by a woman performer, and moving pictures which were three fifths education, were offered in continuous half hour programs by the Goodyear Tire and Rubber Company at the flying field for the company's dirigible balloons.

The Sinclair Oil Co. presented giant reptiles of prehistoric ages which moved, roared, and gnashed their huge teeth. The company's products were advertised by posters on the walls of

the cave. The Standard Oil Co gave a free animal show with a menagerie of live lions, tigers, and elephants which were put through their exhibitions in a steel barred arena.

Union Pacific Gets Second High-Speed Train

(From Railway Age, Oct. 13, 1934)

THE second lightweight, high speed passenger train ordered by the Union Pacific has been completed and delivered to the railroad ready for operation in the transcontinental service between Chicago and the Pacific Coast. This train is a six-car articulate unit, composed of a power car, mail-baggage car, 3 sleepers, and a coach buffet car.

Aluminum-alloy construction is used throughout with the exception of the power plant, bolsters and endsills, and steel trucks. This train differs from its 3 car predecessor primarily by the inclusion of sleeping cars, Diesel-engine drive, and all auxiliary equipment mounted in a single power car. The new train is 376 feet long and weighs 210 tons, including all equipment, fuel, and water. The equivalent steam train weighs about 700 tons.

The power car is 48 feet long and is devoted to the power plant and auxiliaries. The second car is 64 feet long and has 33 feet for mail purposes, the balance being used for a baggage compartment and for heating and air-conditioning equipment. The third and fourth cars are 65 foot, 24 passenger Pullman sleepers. The fifth car is also 64 feet long, having accommodations for 20 passengers. The rear car is 72 feet long, being a 56 passenger coach. The total passenger capacity is 124.

The Winton 900 h.p., 12 cylinder, 2-cycle, V-type, Diesel engine used to drive this engine is the first of its type to be used in American railroad passenger service. It will deveop 900 h.p. at 750 r.p.m. The engine proper is 20 feet in over all length and weighs 18,000 lbs. The main generator weighs 11,700 lbs., and the four driving motors weigh 26,400 lbs. The weight of the entire power plant, including engine, generator, motors, auxiliary engines, generator sets, pumps, radiators, air compressors, etc., is about 79,000 lbs.

The G. E. generator, which is directly connected to the engine, carries a built-in exciter, so designed that the current demand of the traction motors regulates the amount of generator voltage in such a manner that the load on the engine is constant at any car speed and solely under the control of the engine throttle. The traction motors, rated at 300 h.p. each, are mounted, two on each truck, and geared to the wheels.

An auxiliary generator unit consisting of a 4 cylinder two cycle oil engine, is directly connected to a 220 volt, phase a.c. generator. It furnishes power for control, lights, air conditioning equipment, heaters, and pumps.

The power car weighs, fully equipped, 163,000 lbs., or 81,000 lbs. on the front truck. The bed for the main and

auxiliary engine is formed of two aluminum plate girders, which extend from the rear end sill of the car to the front end, and frame into the floor construction at the front end. The floor line construction forms the center of the curved front end, and all of the sectional members connect to form a strong parabolic arch which should resist, without damage, the shock of any collision at highway crossings.

All trucks are of the four wheel type, with welded frames of high-tensile steel and rolled steel wheels and axles. All wheels and driving armatures are mounted on roller bearings, which are liberally oversized for the weight and speed of this train.

To insure maximum safety for the passengers, all windows are glazed with safety glass. To prevent fogging of the windows, the air between the glass is dehydrated and sealed before the sash is applied to the car.

The air conditioning equipment incorporates the use of the Frigidaire cooling unit. The sleeping cars and the rear coach car are furnished with cooled air distributed through the cars by means of a ceiling duct which has outlets through the grilles and is returned to the conditioning car through underfloor ducts on each side of the car.

The entire train, except the power car, is heated by hot air forced through underfloor ducts. Air is returned to the heat generators through a ceiling duct on the center line of the cars, where it is mixed with fresh air brought into the system from outside of the cars.

The cab in the front end of the car is equipped with a hot-water heater taking hot water from the main engine jacket.

Glass-Lined Steel Developments

From Chemical & Metallurgical Engineering (Oct., 1934)

AN entirely new departure during the last year has been the development of a glass-lined, acid-resisting valve by the Pfaudler Co., which already has had extensive use in the chemical and food industries. The principal of the valve is the compressing of a tough, resiliant diaphragm between two metal surfaces. The valve body is entirely lined with acid-resisting of a tough, resiliant dipragm berubber, Thiokol, or Duprene, depending on service. Another development of glass-lined steel equipment is the small scale autoclave. It is built for a pressure of 1,000 lb. per sq. in.

This same type of equipment has become more extensively used in dyeing, bleaching, and finishing operations because it is chemically resistant, nonabsorpsive, and easy to clean. Due to its high resistance to acid, glass enamel is particularly well adapted for the dyeing of wool, where the bath is usually on the acid side. It is now possibe to obtain glass-lined, steel, piece dye kettles of the conventional rectangular sloping-back design, including accessories such as guides and whiprolls of the same material.

ENGINEERING PROGRESS

NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

Fire Extinguisher

A NEW type of fire extinguisher designed to overcome disadvantages of the old style hand-operated has recently been placed upon the market. This "machine-gun" extinguisher has the pump on the outside of the cylindrical container, where it can not gum up, jam or corrode. The pump never comes on contact with the liquid, only compressed air, which forces the liquid out under pressure. A quick lift of the pump and the new fire extinguisher supplies a steady stream of the liquid directly at the base of the flames. This extinguisher is easier to aim, and operates with machine-gun accuracy. Its liquid will not leak or evaporate for it is hermetically sealed when not in use. The liquid is a non-conductor of electricity and will also withstand a temperature of 52 below freezing. The pump and nozzle fold down alongside the extinguisher when not in use. In action the pump is raised quickly, which instantaneously opens the positive sealing valves. Valves close automatically when the pump is lowered, shutting off the stream and saving the remaining liquid. This kind of pump will give better fire protection with much less chance of mechanical failure.

New Heat Insulation Material

Dr. S. S. Kistler, professor of chemical engineering, University of Illinois, has perfected a new heat insulating materia called "silica aerogel." It is composed of a fine network of purest sand, interlocked with air and is extremely light in weight. The most powerful microscope is unable to reveal its texture and its insulation power is estimated at fully 10 per cent more than that of still air. It is from 59 to 100 per cent better than the present commercial heat insulators.

Professor Kistler states that the new medium will stand a temperature of 1500 deg. F. and that "as a heat insulator for refrigerators, electric ovens, and furnaces it should be more efficient than any other material now available."

The gelatinous silicic acid is first prepared by acidifying water glass and then eliminating everything except silicic acid, a loose combination of silica and water. This gelatinous material is known as a hydrogel. In order to convert it to the aerogel, the water must be replaced by air. This, it is said, has been done successfully.

Silica aerogel also may be used in vacuum bottles in place of silvering to

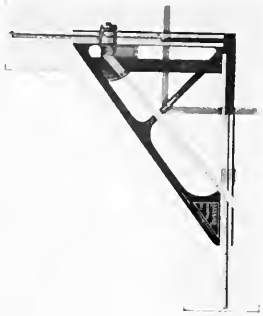
prevent radiation. A layer of one inch of the powdered aerogel in a moderate vacuum being as good as a many times better vacuum between silvered walls. This is partly due to the large surface, said to be about 25 acres for each pound of aerogel.

A New-High Capacity Circuit Breaker

A new high voltage, large capacity oil circuit breaker radically different in design has recently been developed by engineers. Each single-pole unit is shaped like a cross in contrast with the tank-like construction of conventional equipment. Horizontal containers not much larger than bushings on the conventional breakers enclose the interrupting mechanisms. These elements consist of several sets of contacts in line, so arranged that oil driven by a piston is forced across the arc path of each of the arc breaks during circuit interruption. Higher breaking speeds with short arcing times and the use of very little oil are among the advantages offered by the new equipment. Only 96 gallons of oil per pole is required on the new high capacity breaker compared with 1,700 gallons required for a conventional breaker of an equivalent interrupting rating.

Trianalyst

The first contrivance of its kind to receive a patent from the U. S. Government, and based on novel geometrical principles, the Trianalyst performs various mathematical operations giving graphical approximations of results to useful degrees of accuracy. It affords apparently, for the first time in history, a direct means of solving numerical algebraic equations and gives, usually, with little or no incidental computation, the roots of quadratics, cubics, and biquadratics as well as the roots of certain restricted forms of still higher equations and various classes of simultaneous equations. In addition, one, two, or three settings of the parts present the solution of any one of numerous complicated formulae involving multiplication, division, addition, subtraction, and powers and roots of numbers expressed in one moment of combination. Some of these comprise each as many as twenty arithmetical operations. Logarithms are read off directly. By reason of its triangular form the Trianalyst functions also in the trigonometric field. The 1934 invention is distinctly different from a prior calculating device of the same Barrett R. Wellington of Troy, N. Y., patented in 1932. The new model as now made weighs about ten ounces and can do much greater number of determinations.



Insect Plane

Something new and unusual in airplanes comes from Austria, where a scientist, after studying the flight of insects, has invented a plane that has no rudder and has no propeller. The craft has a length of about 38 feet and has two 13-foot forward wings and two rear ones 10 feet long, which serve as propellers. These wings are divided into a multitude of pneumatic cells which are made to pulsate by alternately charging or evacuating them with air. The wings are attached to the metal frame by elastic joints, and have a movable trailing edge so that they can be manipulated to control the craft. The inventor claims that the flying machine can rise and descend almost vertically, hover apparently motionless, and travel forward and backward. How much speed the airplane can make with its pulsating wings and 10 hp. motor is not divulged.

Locknut

An automatic locknut fitting any standard thread, and said to be simple in design and highly efficient, is now on the market. A locking pin which is built integrally with the nut is made of chrome-vanadium rustless steel with a high percentage of nickle. When applying the nut, this pin is engaged by the thread of the bolt, following it down until the nut is seated. The pin engages the thread at a slight angle, thus, it is said, establishing a perperpetual lock which is proof against vibration and shock. To remove the nut, it is turned in the opposite direction, throwing the pin over in the other direction, after which it follows the thread of the bolt. The nut is absolutely foolproof and can be put on and taken off any number of times, the same as any ordinary nut, without impairing the bolt threads.

Synthetic Rubber for Pneumatic Tires

Automobile tires of synthetic rubber are an accomplished fact. Severe laboratory road tests have proved them to be equal to and in some respects even superior to tires of natural rubber. It is claimed that the artificial rubber is more resistant to the swelling action of gasoline, kerosene, and other solvents, as well as to the destructive action of the weather; that it possesses a high degree of elasticity and tensile strength; and that it is tough and durable. Heat only is required to vulcanize it. It can be manufactured into tires with the same machinery now in use for that purpose. Du Prene is the name applied to the synthetic rubber, which, among other ingredients, is compounded of coal, limestone, salt, and water, all of which are to be had in abundance in the United States. As natural rubber has to be imported, the significance of this discovery cannot be overestimated. Already steps have been taken to use Du Prene for other commodities than rubber.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

OF primary interest to the many alumni of Armour Tech is the appointment of Mr. William N. Setterberg (Arch. '29) to the position of Placement Officer at the Institute. His effective work in this capacity has already made itself evident in the ever increasing number of graduates who have obtained work through his efforts.

C. A. Beckman (E. E. '27) is with the Viking Corporation of Chicago, and at the present time is covering the eastern section of the country for them, selling the casings which they produce.

E. E. Bolte (M.E. '27) is, at present, working for the National Radiator Corporation in Chicago. His brother, C. L. Bolte (Ch. E. '17) is situated in Tiensin, China with the regular army, and intends to be there for at least another year. Wonder if he has tea with Gen. Chiang Kai Shek?

Leo Wormser, Chicago lawyer and personal attorney for the late Julius Rosenwald was killed on August 10 as the machine in which he was driving from Chicago to Charlevoix, Mich. overturned. His daughter, who was with him, was uninjured. Mr. Wormser was a member of the Armour Board of Trustees, and his loss is a great one to the school.

Allan Q. Grant (M.E. '20) was appointed assistant principal of the Crane Technical High school recently. Mr. Grant became dean at Crane in September, 1932, but since the removal of the dean's office a year ago, he has been an administrative adviser in addition to teaching mathematics.

He began his teaching career in 1922, and became an instructor in mathematics at Crane in 1925. Three months later he undertook the duties of his first administrative position when he became business adviser of the school newspaper. He served in this capacity for several years, after which he became the school's financial manager. This was followed by his promotion to the dean's office.

George J. Jennings Sr., 57 years old, a retired engineer, died recently of a heart disease at his home at 8131 South Bishop street. He is survived by his widow, Clara; a daughter, Mildred, and a son, George Jr., (E.E. '31) who was state tennis champion in 1929, and won the national public parks tennis title for four years from 1928 to 1931.

"I'm a woman of few words," announced the hauty mistress to the new maid. "If I beckon with my finger, that means 'come'."

"Suits me, mum," replied the girl, cheerfully. "I'm a woman of few words, too. If I shake my head, that means 'I ain't comin'."

* * *

Wise Guy: I guess your date wasn't so good last night—don't try to tell me you got that black eye off a bed-post.

Don Juan: Hell, no, I didn't get anywhere near a bed-post.

* * *

Sure! I can get a girl for him.

Landlord (to prospective tenant): "You know we keep it very quiet here. Do you have any children?"

P. T.: "No."

"A piano, radio, or victrola?"

"No."

"Do you play any musical instrument? Do you have a dog, cat, or parrot?"

"No, but my fountain pen scratches a little sometimes."

Scotland Scores

In an English political oration: "I was born an Englishman, I have lived an Englishman, I hope I shall die an Englishman."

From the back of the hall in an unmistakable accent, "Mon, hae ye no ambeetion?"

* * *

Doctor (to absent minded professor): "The stork has just arrived."

Prof.: "Sh-h-h, don't bother the wife. She's in the next room."

* * *

It was back in medieval times.

"It's no fun trying to live in this coat of mail," complained a cootie.

"No," agreed a second. "Heaven help a feller on a KNIGHT like this."

* * *

Wife: "Dear, I've set my heart on a Rolls-Royce."

Hubby: "Yes, and that's the only part of your anatomy that'll ever set on one."

An EE in the Bud

"Darling," asked the new bride, making out the daily budget, "should the light bill be charged to 'current expense'!"

* * *

Chauffeur: This, madame, is the hand brake—it's put on very quickly in the case of an emergency.

Madam: Oh—something like a kimono.

* * *

Cohen (entering delicatessen): Give me some of that salmon.

Proprietor: That's not salmon, that's ham.

Cohen: Vell, who asked you what it was?

* * *

Then there was the freshman who couldn't understand why he had to take courses in husbandry to get his bachelor's degree.

* * *

It seems that during the depression, a contractor, who was up against it, hired out as a window decorator. On the second day it seems, he mixed the labels and was fired. Underneath the bathtub he had placed the one which belonged on a fur coat. It ran: "How would you like to see your best girl in this for $47.50?"

* * *

Since there was no clergyman present at the banquet, the toastmaster singled out a pious-looking old man in a black coat and tie and asked him to pronounce the blessing.

The old boy put his hand to his ear, replying, "I see you are addressing me, sir, but I'm so damned deaf that if hell froze over I couldn't hear the ice cracking."

* * *

A Scotsman on a visit to a friend outstayed his welcome. His host thought that a hint might have the desired result.

"Don't you think," he said, "that your wife and family will want you to be with them?"

"Mon," replied the Scot, "I believe you're richt. It's rale thoctfu' o' ye. I'll just send for them."

G-E *Campus News*

GOOD-BYE, SMOKESTACK

For many years, the old central heating plant at Mt. Holyoke College, in Massachusetts, with its tall, unsightly smokestack, barred the way to certain necessary improvements and landscape developments on the campus. This summer the old boilers and the smokestack were torn down. In one of the buildings of the old plant stand 120 General Electric oil furnaces arranged in circular groups of five. Fifty-two more G-E oil furnaces are installed in the smaller or more isolated buildings of the campus, operating singly, in pairs, and, in one instance, in a battery of 10. In the central plant, only as many groups of furnaces will operate as are necessary to maintain the required steam pressure. The remainder will be shut down, avoiding stand-by losses. The individual furnaces and small groups in distant buildings permit the abandonment of some of the longer runs in the underground steam-distribution network. The high efficiency of the system is expected to produce savings which will pay for the installation in five to seven years. In addition, as a result of the more careful regulation of temperature, it is expected that health conditions at the college will be considerably improved.

The main plans for the system were drawn up by C. W. Colby, consulting engineer. D. W. McLenegan, Wisconsin, '21, assistant engineer of the Air Conditioning Department; W. O. Lum, and H. R. Crago, Penn State, '18, both of the same department, handled engineering details for General Electric.

TWO POLES IN ONE

Radio entertainment and "airmail" have been sent to the Antaretic through General Electric's short-wave station W2XAF, ever since Rear Admiral Byrd arrived there last year. Recently, in conjunction with a Byrd program, another was sent out to Rockwell Kent and his son in the Arctic region—thus linking simultaneously Americans who are, in the matter of latitude, farthest apart. Governor McNutt of Indiana and other prominent Hoosiers spoke to the Byrd Expedition from Indianapolis in a program sponsored by the *Indianapolis Star*. Immediately afterward, the Coffee House Club, an organization of artists and writers to which Rockwell Kent belongs, sent music and greetings from New York to him on the island of Ubekjent, just off the coast of Greenland, 600 miles within the Arctic circle. Features of this program were special greetings from Mrs. Kent and her daughter, and a talk in the Eskimo language by Vilhjalmar Steffanssen, Arctic explorer, for the benefit of the natives. Both programs were broadcast over a coast-to-coast NBC network as well as by short waves.

FLYING POWER PLANT

Gold was discovered in 1925 along the Bulola River in New Guinea, an island just north of Australia. Prospectors worked the richer veins by hand methods, and packed their "take" on the backs of natives through 40 miles of cannibal-infested and nearly impassable jungles to Lae on the coast. After the best veins had been worked out, it became apparent that placer operations on a large scale would pay if the necessary dredges and other machinery could be brought to the location. Land transportation was impossible, so a plane was sent in. The pilot found a spot to land, and a flying field was cleared off.

Four 875-kv-a. General Electric waterwheel generators were among the equipment ordered. When they arrived at Lae, they were transferred to huge all-metal Junkers freight planes and flown to the location piece by piece. The largest single pieces had a net weight of 6545 pounds. As the load limit of the planes is 7000 pounds, it was a tight squeeze. D. B. Gearhart, Iowa State, '27, of International General Electric, Inc., handled the order for the Company.

96 83FBI

GENERAL ELECTRIC

In A Jointless-Minded World

Welding would prevail—and old methods of joining could not be restored to favor.

By E. A. DOYLE*

If welding had become the standard method of manufacture before mechanical types of joints were introduced, it would be difficult, indeed, to convince manufacturers that they should redesign their metal products to use mechanical methods of joining.

NO RETREAT—pipe line constructors would never consent to a change from simple, portable welding equipment to the complicated devices essential to other methods.

Welding Gives Strength

Strength would be a talking point for welding. The welded joint is strong as or stronger than the metal which it joins. The cutting of holes for screws or bolts would naturally weaken the structure. Appearance gives welding another vote. Joints made by welding are smooth in contour and have no depressions, bosses, projections or attachments as is often necessary in mechanical means of joining metals.

Costs Less to the User

Cost would be another argument for welded joints. The greater amount of material necessary with mechanical joints, the increased weight, and the decrease in pay load or performance-to-weight ratio, would make welding the preferred method. Nobody would consent to a joint in piping, which might, through a tiny leak cost much more than the permanently leakproof welded joint. Nor should it be necessary to buy expensive machinery to make mechanical joints which welding can equal in performance, economy and adaptability with a minimum investment in metal fabricating equipment.

Modernizes Automobile Design

Automobile manufacturers would insist on welding rather than consent to a return to the design limitations imposed by mechanical joints. In face of a change from "teardrop" designs to the old boxlike bodies, with the attendant discomforts, with higher cost due to increased gas consumption and increased tire wear, with the fear of accidents increased by the lack of confidence in the joints, with appearance impaired and lacking the smooth surface for fine paint and lacquer finishes,—the automobile manufacturer would hesitate long before any but welded joints would even get a hearing.

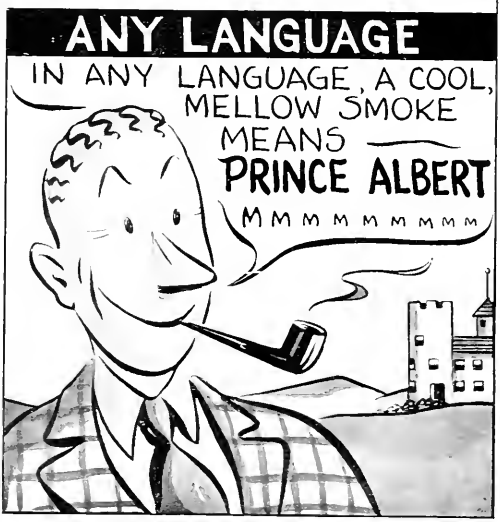
METAL FURNITURE—The welded joints in metal beds, chairs and other similar furniture assure a sturdy and rigid assembly.

In the Future

Farsighted industrial executives can appreciate that a completely "welding-minded" industrial world is not far off. They should use in their own manufacturing operations as many of the advantages of welding as possible. The welding engineers of The Linde Air Products Company can advise how oxy-acetylene welding could best be used in your plant. This service is obtainable without cost or obligation by application to any of the sales offices of The Linde Air Products Company located at Atlanta, Baltimore, Birmingham, Boston, Buffalo, Butte, Chicago, Cleveland, Dallas, Denver, Detroit, El Paso, Houston, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Phoenix, Pittsburgh, Portland, Ore., St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, and Tulsa. Everything for oxy-acetylene welding and cutting—including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through plants and warehouse stocks, everywhere.

BEAUTIFUL USEFULNESS—typified in this welded ornamental iron gateway. Every joint is strong, sound and was made inexpensively.

*Chief Engineer, Development Section, The Linde Air Products Company, New York. Unit of Union Carbide and Carbon Corporation.



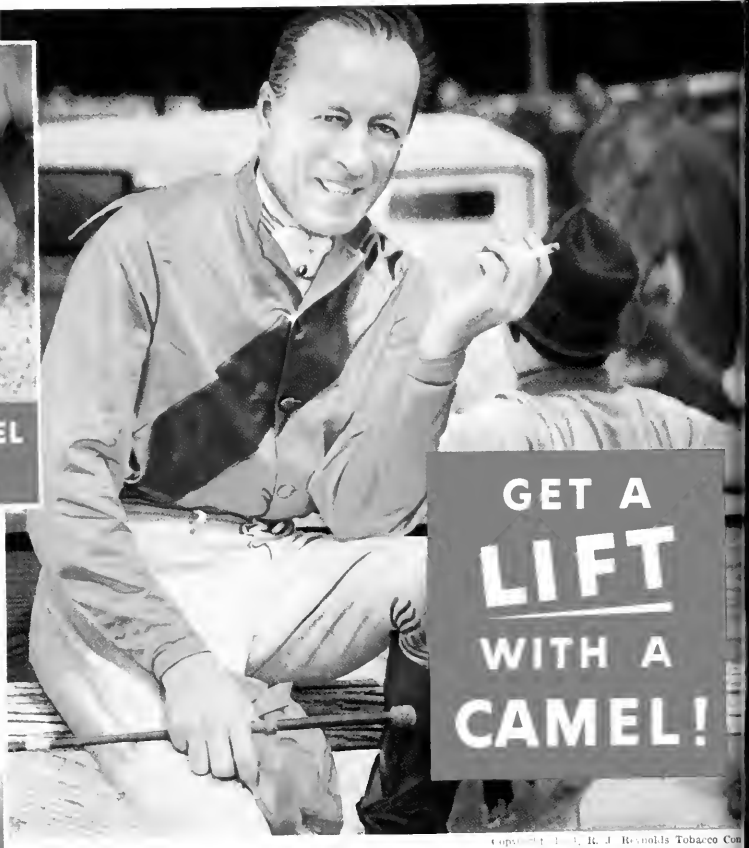
AFTER EVERY CLASS IT RINGS THE BELL!

PIPE SMOKERS! Here is a fact to bear in mind about Prince Albert. *Prince Albert is blended by a special process which removes every hint of "bite" or harshness from the tobaccos.* So try this mild, mellow tobacco. Discover for yourself why Prince Albert is known among men everywhere as "The National Joy Smoke."

PRINCE ALBERT *the national joy smoke*

WHEN YOU FEEL "ALL IN"—

CRAWFORD BURTON, gentleman rider, twice winner of the Maryland Hunt Cup, dean of the strenuous sport of steeplechase riding ...a Camel smoker. Everyone is subject to strain. Hence the importance to people in every walk of life of what Mr. Burton says below about Camels.



GET A LIFT WITH A CAMEL!

HAVE YOU TRIED THIS ENJOYABLE WAY OF HEIGHTENING ENERGY?

COLLEGE STUDENT. "When mental fatigue sets in," says John Birgel, "I just smoke another Camel and soon have the energy to concentrate again."

REX BEACH, famous sportsman, says: "When I've gotten a big game fish landed I light a Camel, and feel as good as new."

As this magazine goes to press, reports pour in from all parts of the country...showing that thousands of smokers are turning to Camels...and that they *do* "get a lift with a Camel."

Here's a typical experience. Mr. Crawford Burton, the famous American steeplechase rider, is speaking:

"Whether I'm tired from riding a hard race or from the pressure and tension of a crowded business day, I feel refreshed and restored just as soon as I get a chance to smoke a Camel. So I'm a pretty incessant smoker, not only because Camels give me a 'lift' in energy, but because they *taste so good!* And never yet have Camels upset my nerves."

You have heard the experience of others. Science tells us that Camel's "energizing effect" has been fully confirmed.

So try Camels yourself. You can smoke as many as you like. For Camels are made from finer, MORE EXPENSIVE TOBACCOS. They never taste flat...never get on your nerves.

ALL TOBAC
MEN KNO
"Camels are m
from finer, M
EXPENSIVE TO
COS — *Turkish*
Domestic — than
other popular bra

Camel's costlier Tobaccos never get on your Nerves

THE ARMOUR ENGINEER

FEB. 1935

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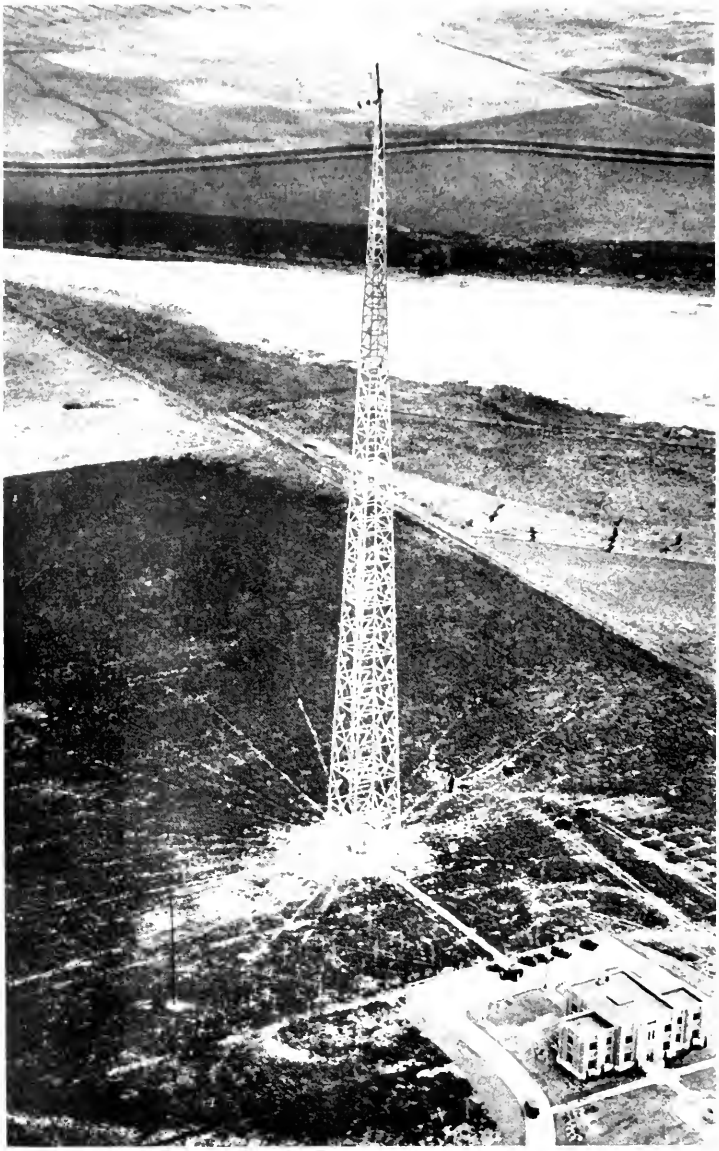

Courtesy Gen. Elec. Co.

THE SPIRE OF RADIO

THE
ARMOUR ENGINEER

FEBRUARY, 1935

My Private Filing System

By H. P. DUTTON

AN ENGINEER was writing a report when suddenly it came to his mind, "Where did I see that reference to the probable population of the United States in 1950?" Since the question was vital to the argument he was developing, he spent the next two days in a long search, among all the possible sources for the information, finally digging it up in a technical journal which, unknowingly, he had in his own library.

An enormous amount of information passes through the hands of every studious or busy man in the course of a year. How much sticks? By the nature of things, one cannot possibly encumber his mind with every detail. The mind extracts from the fact the significance which appears important at the moment. This impression is gradually fused with many other related ones. One remembers the fact, but forgets the source.

But even this much retention is impossible for the average man who tries to keep in touch with his profession. Papers, journals, and magazines—the

Editor's Note: H. P. Dutton is lecturer in Business Management at the Institute and associate editor of Factory Management.

postman dumps down a new load before one has more than glanced through the old. Announcements of books—no time for them today, but we may need them sometime. Names—those vital contacts with new brains, with opportunities, with information. Today we meet the man. Next year we are trying vainly to remember who he was, or where he lives, or what his initials are.

Twenty years ago, or less, I took a course in accounting. Ten years later I was called on to set up the accounts for a business in which I was interested. Fortunately, I had sundry notes and problems. I went back to them, quickly found my way back through the old familiar entries, and had merely to duplicate the problems to devise a workable system for my business.

There are various methods of retaining useful facts. We cannot retain them all. The memory holds only the most essential. Unless the memory is a prodigy of retentiveness, or the facts are few, one cannot rely on memory for sharp details of numbers, name, and place. For that we rely on the written record. But merely possessing written and printed records is not enough, for presently in the vast litter of unassorted facts it becomes more troublesome to locate the record than to perform the experiment or computation again. You have probably heard of the man who was in great trepidation as to where to put a valuable bond. "Put it in the files," said his partner. "No one has ever found anything there yet." Information preserved but not classified is useless.

Should an Engineering Student establish a filing system? The idea sounds a little ponderous—one calls to mind the picture of the salesman, calling on the customer for whom he had recently installed a filing system. "Good morning, Mr. Jones. And how is the new system?" "Fine, fine," says Jones, and waves to a vista of clerks pulling out drawers of records, putting cards in cabinets, and similarly occupied. "And how's business, Mr. Jones?" "Oh, we've given up business. We haven't had time for it since we've had to keep up the files."

There's a danger of letting the mechanism become an end itself. But an intelligent filing system takes very little time. I usually take some Saturday afternoon when I don't feel like doing anything else, once or twice a year, to check it over, and a couple of hours every few Sundays to sort and file accumulated papers.

One can go to great lengths in symbolizing and cross-indexing. Such elaboration is necessary with large and important masses of material, as books in a large library. But for most private files, the only step necessary is to sort the material according to its most likely future interest. In my case, the first head division is between correspondence, records of business transactions and the like, and data. In my correspondence file I have folders for paid bills, for correspondence about insurance, a file on Armour

courses and another on Northwestern courses, a file for each committee of which I am a member, several, according to subjects, for various professional societies, and one or more for each job I happen to be doing. Last Saturday I found at the last moment that it would be necessary to attend a meeting of the Oil Pumping Engine Code Authority, in Verdand. All I had to do was to go to the files, take outfolders marked "Oil Pumping Engine," pick up my book of NRA regulations (also indexed for quick reference) and pack my bag. On the train I had a chance to glance back on the business accumulated since last meeting, so that the next morning I was prepared.

In such a file, in various folders, may go personal budgets and accounts, New Year's resolutions and projects (they make interesting reading later and sometimes remind one of possibilities), correspondence about jobs, letters from home, fraternity business, clippings from the Tech news, or what have you. Once every year or so one can go through these personal, transient files, dump finished matters into the waste basket, and transfer important records to a permanent file.

Folders for the correspondence file may be simply cheap manilla folders, about 8 1-2 by 11 inches, with a tab or raised margin on which to mark the file name. One can buy these folders for a few cents, or improvise them from any stiff paper. For a filing cabinet, one can get fine stands of vertical filing drawers running on roller bearings in a steel case, or he can stand the folders upright in an improvised cabinet made out of a reconstructed grocery box.

The second file is the data file. This I divide according to my major interests. Typical file sections for this would be "Financial Reports," "Budgeting and Cost Control," "Marketing," "Time and Motion Study," and the like. An architect might want to file under "Foundations," "Small Homes," "Bids and Estimates," "Roofs," "Windows," "Design," and so on.

Into this file go all the transient circulars and reports which may later be so useful. I have a habit, after I have read a magazine, of tearing it apart and saving articles which interest me. Each technical article is clipped together, the name and date of the same is scribbled on it, and it is put into the appropriate file. The non-technical ones, I accumulate (again under a rough classification as "Stories," "Education," "Travel," and so on), until I have enough to bind into a volume. One cannot tear all the magazines he reads apart. Certain ones, in which nearly every article may be important, I preserve entire and occasionally have bound. Things one reads in libraries and wants to keep may be abstracted. (Onto a card not into your coat pocket, of course.)

If one does a great deal of professional reading, the best method of ab-

stracting is probably to take a 3x5 or 5x8 card and head the card with the name of the book or article. In careful work, be sure to record date of publication, name of author and of publisher, and page number, so that the item can later be traced back with out trouble if wanted. Then comes an outline of the important points in the article. These cards then go into the card index, classified by subject. In my own case, I do most of my filing on sheets of pocket notebook size (3 3-4 by 6 3-4 inches, the so-called "Lefax" size) and transfer them from the notebook to either the subject folder or to extra books where the material is classified by subject.

These data files are usually bulkier than correspondence. Plain folders are soon outgrown. Stationers sell cloth-bound expanding file pockets which are very convenient. These can be set up side by side on a shelf of an ordinary book case. As one accumulates more material on "Marketing" than will go into one folder, he goes through his files one day and sorts his material into "Market Analysis," "Sales Management," "Compensation for Salesmen," and so on, subdividing indefinitely as one's interests and the volume of his material grow.

Names and addresses are not usually as important to the student as they are after graduation. In my own case, when I meet and do business with an International Harvester man, down goes name, initials, title, address, and the occasion for the contact on a page labeled "International Harvester Co.," in one of several loose leaf note books. Other classifications in these address books are for practicing engineers, publishers, schools, and so on.

Two or three years later, one of our salesmen may want to know where he can get some information about costs of spray painting. I vaguely recall that I talked to somebody in Milwaukee about it. If memory gets me no closer, I look through all the Milwaukee addresses for the next clue. Usually I can "get my man."

One very useful appendix to this filing system is my "little black book." Really, I shouldn't mention this, for it contains all my grades and some dark night an enraged senior in Social Science 401 may hold me up and relieve me of all records of his melfeasance. (The only thing to do in that case, I suppose, would be to flunk the senior, and if necessary the class.) In this little black book, a ring binder $3\frac{3}{4}$x$6\frac{3}{4}$ which may be bought for a dollar or two, go

(1) A calendar.

(2) A check record and pocket for blank checks.

(3) An appointment file, ruled vertically by days and across the page by hours. (Sometimes I forget to look at the book. Then I have explanations to make to my dentist. But I tremble to think how many student conferences, committee meetings, and other engagements I would miss without it.)

(4) Class rolls and student records.
(5) Blank paper for notes, etc.

Into this book I can slip for special occasions notes on plain sheets, company lists, or anything else. It is a veritable travelling office. I mislaid such a book this fall, for the first time in ten years. Because of such a possibility I duplicate class lists and was able to transfer the rolls without trouble. The bank balance had to be picked up from next month's statement. My Century of Progress Editorial Pass was gone. But, in the main, one seldom loses such a book, for he can't afford to.

How does one keep from being swamped by his files? There is no need to be overwhelmed when you know how to file. Your files can be kept down to the dimensions of a note book or two in your trunk, while you are on traveling jobs, or expanded to fill the attic, the basement, the front closet, and half the family library when you have your roots fairly deep in one place for a while.

The first principle of selection is to decide when you first handle a piece what you are going to do with it. My pet vice is to procrastinate, to save the piece, and paw it over two or three times before I consign it to the waste basket. It's a good thing to mark the file into which the piece is to go. This habit's especially valuable when one has a secretary to do his filing.

The next stage is the periodical clearance of the file. Transient matters should go into transient files, which can go entire into the waste paper basket after a year or other interval. And it is a good thing, every couple of years, to go through the data and permanent files, discard the stuff that is out of date, and get acquainted again with things you have forgotten.

Good engineers advise the beginner to save every scrap of computation. You never can tell when you'll have to check over or justify your work, and rough memo on a lot of scratch paper may save the day. Files are useful at examination time, and are more than likely to be of great value later. And the habit of filing makes a substantial difference in one's later life. A man who has learned to file effectively, unconsciously, frees his mind from a thousand trivial yet often essential details.

I certainly shouldn't advise making a fetish of a filing system. But some afternoon when you know you ought to be doing that problem in mechanics, and are looking for an excuse to evade the issue as long as possible, give an hour's thought to a filing plan of your own. Once rightly started it almost takes care of itself, and without sensible effort grows more valuable each year.

While things are bad enough as it is, I would be lost without my file. And so will you, and wonder how you ever got along without them, once you start the practice of systematically filing your personal, financial, technical, professional, and other records.

Color Photography

By RAY MANSFIELD

FROM the earliest days of photography, the hope of being able to reproduce the colors of nature through the medium of the photographic plate has been both widely and seriously entertained. Time has dispelled many illusory anticipations but the hope remains, and to some extent has been actually realized.

In 1839 Daguerre's carelessness gave us photography—today Walt Disney gives us "Three Little Pigs," "La Cucaracha" and "Kid Millions," made possible through the findings of Daguerre.

First True Photograph Developed

Before Daguerre's discovery there was a tedious, impractical method called Camera Printing in which it was necessary to expose the photographic plate for eight hours to obtain a picture. Then one day Daguerre stored a plate which he believed spoiled by under exposure. In this same closet, he carelessly left an uncovered container of mercury. Vaporized by the heat of the room, the mercury became a reagent. It clarified the image on the discarded plate and developed the world's first true photograph, called the "Daguerreotype." These "tintypes" of Daguerre exhibited a natural color due to interference, a process to be described later.

Some of the earliest experiments include those of T. S. Seebeck, who found that when he projected a spectrum upon paper prepared with moist silver chloride and allowed the action to continue for about fifteen minutes the colors would be registered on the paper. These images, however, could not be preserved.

The celebrated poet, Goethe, took great interest in the work of Seebeck, and the best account of these experiments is preserved in Goethe's "Treatise on Color."

Maxwell Theory of Vision

Clerk Maxwell lectured before the Royal Institution in London on his theory of vision, in which he held that there are but three nerve fibrils in the retina of the eye which respond to all of the colors of the spectrum distinguishable by the eye. One fibril is ex-

Editor's Note: Ray Mansfield, a junior in the department of Electrical Engineering, is well known about the Institute for his efforts in the field of amateur photography.

cited only by the red, a second only by the blue, and a third only by the green. If each set of nerves is equally and simultaneously stimulated, the sensation of white is transmitted to the brain.

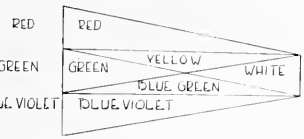

Fig. 1. *Showing mixture of three primary colors to produce white light.*

By varying the intensity of one or more of these primary colors, any color may be transmitted.

The sensitiveness of the eye to each color is not the same but is greatest for green, then yellow, red, orange, blue green, blue, and finally violet. This is known as Purkinjes' Phenomenon, and is due to the association of color sensitive cones with color insensitive rods in the structure of the retina.

Lippman Process of Interference Heliochromy

Before we discuss Color Photography as we understand it today, let us briefly sketch two processes that have come to be "landmarks." Based upon a theoretical and speculative work found in a book on heliochromy published by Dr. Wm. Zencker of Berlin in 1868, Dr. Lippmann worked out a practical process of interference heliochromy. This property of interference waves is fully described in physics books. However, a very convenient analogy is the soap bubble. What happens is that rays of light reflected from the inner surface of the bubble interfere with the rays reflected from the outer surface with the result that colored rays are neutralized exactly according to the changing thickness of the bubble film. This is only possible when the surfaces from which the reflections take place are so close together that a wave of light reflected from one surface is just half a wave length behind, or in front, of a wave reflected from the other. To obtain these results and fix them permanently, Lippmann employed a practically grainless emulsion which he exposed through glass with the sensitive film in contact with a glass tank containing pure mercury. The rays of light thus reflected interfered with the incident rays and produced in the sensitive film laminae or very fine layers of metallic silver, separated by half a wave length of the light that produced them. The response to this process is very limited because of the long exposure necessary (15 to 20 minutes) and the necessary viewing of the pictures at a certain angle. Working details require much skilled patience. It is a difficult and costly process.

A much more encouraging process is the Lumiere Autochrome plate developed in 1907. This was greatly improved by Agfa in 1923.

Lumiere Prepares Autochrome Plate

Lumeiere prepared his plate by sifting potato starch grains to obtain grains of approximately the same size

He divided these grains into three equal portions and dyed one portion red, another yellow, and the third blue. These three portions were then mixed thoroughly and sifted over a plate prepared with a tacky varnish. These grains were then rolled out so as to obtain a smooth even surface. Any interstices between the starch grains were filled with black powder. The plate was given a protective coat of varnish, after which the panchromatic emulsion was applied.

The plates thus prepared were placed in the camera with the glass side toward the lens. In this manner, the mosaic screen formed by the particles acted first as a filter and after development and reversal imparted the natural color to the plate.

The Agfa color plate has a three-color screen similar to that of the Autochrome except that dyed particles of gum arabic rolled out in collodion are used. For this reason the Agfa color plate is much faster than its predecessor and is today commercially successful. However, both of these color plates and a host of others copied after them must be viewed by projection and therein lies the drawback to their more universal use.

Trichrome Carbro Process Used Commercially

Trichrome carbro, or a variation thereof, is the process most used in commercial color photography today. To understand this process one may think of a picture being composed of three separate and distinct color pictures superimposed to give the blended result of the finished picture.

It is necessary to take three different pictures of the same object, one corresponding to the red portions, another to the blue portions and a third to the yellow portions of the object. After subsequent processing these three pictures are dyed and superimposed in exact register on a white mount. Thus, we have a reproduction in color. Several factors of importance enter into the production of a color photograph. The first consideration is that of exposure and viewpoint. One of the earlier cameras was developed by Messrs. Sanger and Shepard. The unique feature of this camera was a sliding back which contained three negatives placed behind their respective filters. Thus when the negative which is to record the red portion of the picture is placed behind a green filter which cuts out all of the other light and exposure is made, the back is moved such that the next negative is to record the yellow light reflected from the image (the filter in front of this negative is the blue violet). After the necessary exposure, the next negative is moved into position and similar operations are performed. A good feature is that these three negatives are all on one plate and therefore have the same conditions of development such as temperature and time, two very important factors in this work. The chief disadvantage is that this type of camera could not be used for moving objects due to the time re-

quired for setting the back.

Mr. E. T. Butler developed a useful camera constructed on the principle of Ives Chromescope, which is in all evidence the forerunner to the "one-shot" color-camera in use today. The Butler camera employs an optical system that splits the beam of light into three parts by means of prisms and half-silvered mirrors. The light beams then travel through filters to the plates. Thus one exposure is required to record the image on all three plates, hence eliminating any error in relative exposure such as was present in the Sanger-Shepard camera.

Cameras similarly constructed are used today by the Conde Nast publication and more recently by R. R. Donnelly for the production of direct color prints. These cameras are highly accurate and rather expensive.

The negative material used for this work must be fully color-corrected, therefore the films ordinarily used would not be suitable as they are insensitive to the longer wave lengths of light (Red end). Furthermore, the ordinary film is over-sensitive to the blue and ultra-violet light (short wave lengths). For this reason the panchromatic emulsions have been developed.

When the three negatives have been obtained, it is necessary to develop and print them in colors. There are two ways in which to obtain these color prints. One method is called the inhibition process and is described in conjunction with cinematography.

Carbon Printing

Another method is that of carbon printing. It is based on the fact that, if a film of a colloid substance, such as gelatin, is sensitized in a solution of potassium bichromate and exposed to light, it becomes insoluble in water. It follows that, if such a sensitized film is exposed behind a negative, the light striking through the transparent parts of the negative renders the film under those parts insoluble, leaving the denser parts soluble according to the depths penetrated by the light. If the exposed film is now developed in warm water part of the gelatine will be washed away and part of it remains. Thus we have a picture in insoluble gelatin. By mixing a pigment with the gelatin, the picture can be made clearly apparent, but in practice it is necessary to transfer the exposed pigmented film from its original support to another support for purposes of developing. Since carbon tissue can be obtained in almost any color, the problem is solved by making three separate prints of yellow, red, and blue carbon tissues. These three prints are successively transferred to temporary supports of transparent celluloid (previously waxed) and on these temporary supports they are developed in warm water much the same as the carbon print. We now have a set of three colored prints on celluloid, one in yellow representing the part of the picture after the absorption by the blue-violet filter, one red image representing the part left by the green filter, and

the same with the blue image. By transferring the yellow image to its final support and superimposing the red image on it, we have an orange image produced by the combination of the two. Now placing on top of this the blue image in exact register we have a faithful reproduction of the original.

This may look easy in prints but the pitfalls are many and varied. The greatest trouble is that of registry. It is rather difficult to tell when the images are in exact register because of the nature of the work. Glass support is mostly used because celluloid will be distorted with a change in temperature and at the best the very fragile gelatin image may warp in the processing. Temperature and air currents are carefully checked in the laboratory. As may be suspected there is a great percentage of waste in this work, often making the cost of a finished picture as much as five hundred dollars exclusive of "set."

Cinemacolor

Ever since the invention of motion pictures, natural coloration in the films has been a goal toward which experimenters have worked with but little success until recently. Many schemes have been tried ranging from hand-tinting of the individual frames to the simultaneous projection of three films dyed in three colors. Hundreds of patents have been issued for this work and still experiments are being continued in this field. Numerous attempts have been made to perfect an additive color print process but none has met with any practical success. Subtractive processes are much simpler to work as it is easier to obtain true whites and blacks so necessary to add the contrast needed.

One of the early developments required a special projector comprising three separate sets of mechanism so that the three films could be projected through three lenses and superimposed on the screen. Here it was difficult to obtain a color balance and the process was doomed because of the special equipment necessary for projection. Another difficulty was the slightly different standpoint of each lens. Thus it was impossible to register both the distance and near foreground simultaneously. This defect may be called sterroparallax.

Two-Color Process

Difficulties attending three color-process prompted early workers to substitute two colors for the three. They realized that the results would not be exactly correct but by careful matching a suitable blend of complimentary colors could be obtained. The two colors used were shades of red and green, thus a blue sky could not be obtained. However, this imperfection was accepted at the time.

Kinemacolor

One process known as "Kinemacolor" took pictures on a single strip of film through filters incorporated in

a rotating sector wheel or shutter placed before the lens. The pictures were taken alternately through red and green filters at twice the normal speed and projected at the same speed through a similar device. Considerable trouble from color fringing was found with this method. The principle of the Kinematograph depends on what is called "persistence of vision" and the continued perception of the changing object. When light is reflected from the moving object it forms an image at the back of the eye and produces a nerve current which passes along every one of the fibers which receive the image and collectively carry the impression along the optical nerve to the brain. This sensation is not instantaneous, but is divided into four parts, as follows: (1) a latent period which is almost instantaneous and during which nothing appears to happen; (2) a very short period—probably less than 1/00 of a second—during which the sensation reaches a maximum; (3) a much longer period, 1 30 to 1 10 of a second (the time varying directly with the illumination during which the sensation slowly diminishes; (4) a short period of decline during which the effect dies away. In the case of the moving object on which the attention is directed, the fourth period remains unnoticed because the new image takes the place of the old one before that period arrives. The whole of Kinematography depends on this third period, by which the first impression (Fig. 2) lingers until replaced by the second one, B, and the second one is again replaced by the third one, C, and so on. In this diagram, the height of the curve represents the intensity of the light stimulus and the width measured on the horizontal axis represents the time.

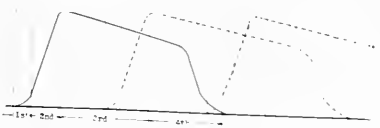

FIG. 2. *Curve representing four periods of a visual sensation. The first sensation is represented by the thick, heavy line, the two succeeding ones by dotted lines.*

Work of Eastman Laboratories to Perfect Color Movies

The Eastman Research Laboratories, under the direction of Dr. C. E. K. Mees, have been working for a number of years to perfect color movies. The most radically new element in the process is the film. Instead of having the usual smooth surface the side opposite the sensitive coating is embossed with cylindrical lenses so minute as to be invisible. These lenses, which are part of the film itself and made of the film substance, would each look (if highly magnified) like a rib of a corrugated iron roof. They run lengthwise of the film with 559 to the inch.

The effect of these invisibly small lenses is to separate the rays of light which come through the three segments of a three-colored light filter into the camera. Each of the three

colors of the filter—red, green, and blue, allows only its own color to enter into the camera. The three differently colored light rays register on the film only as black and white, but each tiny lens embossed on the film distributes the light rays falling upon it so that the different colors register on the sensitive film as a distinct black-and-white impression for each color at that point.

The light of the projector then passes through the film in such a way that it shines out through the tiny film lenses and thence through the projector lens. Each ray is directed through the proper color on the light filter, to fall on its proper spot on the screen. The combination of the three colors, red, green and blue, gives the picture in its natural color.

Today this process is restricted to amateur use, as no method has been found by which to duplicate copies to be used in the various movie houses.

Photo Color Makes Its Appearance

Another two-color process called Photo Color made its appearance in 1930. In this process, the camera is equipped with two lenses and when operated, the negative films at two and one-half times normal speed. This is done because two frames of the film are exposed simultaneously, one through a filter for the red-yellow tones and the other through a filter for the green-blue tones. There is a space between the frames that is eliminated in the printing. In the printing machine, which is accurate to within one-ten thousandth of an inch, alternate frames are printed on one side of a double-emulsion film, and the remaining negative frames on the positive emulsion. Thus the simultaneously exposed frames are registered and combined. When the positive is developed, it is still in black and white. One side is dyed with a green-blue dye and the other with a red-yellow dye, the result being a close approximation of natural coloration when projected on a motion picture screen.

The material presented thus far has been a means of leading up to the technicolor process—which gave us "Three Little Pigs," "La Cucaracha," and "Kid Millions."

Technicolor

Technicolor, Inc., was started in 1921 by a group of physicists who are graduates of Massachusetts Institute of Technology, namely, D. H. T. Kalmus and Dr. D. F. Comstock. Nearly every one who has been connected with Technicolor is a Tech man. Originally they used a relief process, but about 1928 changed to an imbibition process. Let us briefly review these two methods. If a gelatin film is sensitized in a bichromate solution and tanned by exposure to light, it becomes insoluble in hot water. The film is exposed through the back and is differentially hardened according to the amount of silver image formed. A relief image is obtained by washing the fixed-out film in hot water. These

films are then used as a matrix, and are dyed and printed much the same as a rubber stamp.

Color prints by the imbibition process are made by starting with a gelatin coated film and causing the coating to take up successively or "imbibe" dyes from the color images on the matrix. Any number of prints may be made from one group of matrices. The dyes used in this process will only stain soft gelatin. In another imbibition process, the Sanger-Shepard, the reverse is true since it depends on dyes which stain hardened gelatin.

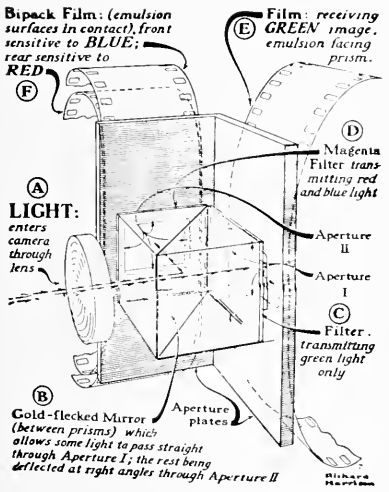

*Fig. 3. *Technicolor's Camera*
*Courtesy *Fortune* magazine.

The diagram above shows a simplified interior of the technicolor three-component camera. By starting at point A and following the artist around the diagram letter by letter it is best studied.

In the Technicolor process the negative or master film is photographed as before, two pictures at a time, one "frame" or picture carrying the component of one set of colors; the next its complement. The developed negative is printed by a mechanism which jumps the negative so that the red separation images appear in a continuous film, the blue images in another continuous film; in other words the positive film is moved forward one frame at a time and the negative two frames at a time. These two films are developed to produce a relief image, and are then run along a steel plate successively under great pressure in contact with the film to be used for projection, the dyed images being printed much the same as the red, blue and yellow plates are printed in making color reproduction in book printing. During 1930, a method was worked out of making color sound prints having a silver image sound track with a contrast or "gamma" of unity which has improved sound reproduction.

Also Technicolor has changed to be a three-color process which partly accounts for its recent success. This work was further simplified by use of a Bipack film in which the emulsion surfaces of the two films are in contact. This can best be understood by inspecting the diagram.

Design of Highway Intersections

By STANLEY BERNSTEIN

THE separation of grades at main highway intersections is a problem that must be faced by every highway department at some time.

In the poorer regions the actual construction of grade separations may be postponed until finances permit. However, it would be well to prepare for the time by solving the legal difficulties that may arise and by deciding where the grade separations will be needed.

A complete study of highway grade separations shows that great expenditures are necessary, but still separations of the sort to be mentioned are the cheapest solution to the problem. The Westchester County Park Commission (New York) has carried forward probably the most comprehensive program of grade separation in the United States. In the immediate vicinity of Detroit, the Wayne County Highway and Park Commissions are jointly building grade separations at points where park drives cross county highways.

A report of November, 1930 stated that at the end of 1929 Cook County, Illinois had 320 grade separations and that 600 were expected to be operating by 1933.

Indiana is completing her Indiana Dune Park project which calls for several miles of super-highway with two bypass grade separations. One of these separations is located at U.S. 12 and the other over U.S. 112.

There are four major types of grade separations used in highway intersection work. The first type is simply a case of two highways crossing at different levels. There are no means provided for turning from one to the other. The second type is illustrated in Fig. 1. In this case, there is an elevated structure which carries the central

Editor's Note: Stanley Bernstein, senior Civil Engineer, is technical editor of the Armour Engineer and a member of Sphinx and the Honor "A" society.

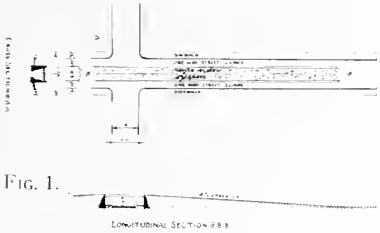

Fig. 1.

part of one highway over and across the other, all other pavements and sidewalks on both roads remaining at grade. This type is objectionable to property owners because it places an elevated structure in the street.

The third type, as illustrated in Fig. 2, is the most desirable from the standpoint of the adjoining property owners. The center part is depressed, all other pavements and sidewalks remaining at grade.

The fourth type, Fig. 3, may be best divided into two types, the single bypass and the cloverleaf. They are both well suited to crossings where public property is available at a low cost. When landscaped, these separations are very pleasing to see. The operation of these devices may be more easily observed from the sketches than by verbal description; however, the reader's attention is called to a few points. These intersections allow a continuous flow of traffic and easy turning from one highway to the other. The cloverleaf gives complete lane separation. This prevents collision from lane overlapping and, because of the various superelevations, allows higher speeds on the turns.

Another arrangement, which does not involve actual separation of grades, but which is rather effective, is known as the Traffic Circle. It keeps traffic moving in both directions on both roads, although traffic on the circle itself is all in one direction, moving counter-clockwise. A driver coming from any direction swings to the right into the flow around the circle and keeps on going around until he comes to the road he wishes to travel. This type of project allows several roads to intersect in one place. It slows up traffic but allows a continuous flow and is comparatively inexpensive.

Between Manchester and Concord, the Daniel Webster Highway, which traverses New Hampshire from south to north, carries a traffic up to a normal maximum of 13,000 cars a day. Due to congestion in the streets of Suncook, it was decided to build a bypass around the town.

The bypass is about 2½ miles long and has a 300 ft. viaduct, a railroad underpass, and a two level highway bridge.

The new road leads off the main highway about two miles south of Sun-

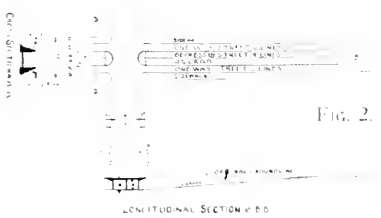

Fig. 2.

cook village and follows a route of easy alignment and grade to the junction with Route 28 at the two deck Suncook River bridge, about a half mile east of the present junction point, and then joins the highway again about a half mile north of the village.

The structure at the junction of the two main highways bridges the Suncook River and eliminates a highway grade crossing of two trunk lines.

The main bridge has a span of 143 feet. There are two 50 foot approach spans on a steel bent at the south end and three 50 foot spans at the north end, all made up of rolled shapes. The roadways of both levels are of reinforced concrete and have a 21 foot clearance. The foundations of the main span are on solid ledge and the piers and abutments of the approach span are set on hardpan or ledge. The total structure includes 1,344 cu. yds. of concrete, 56 tons of reinforcing steel, and 344 tons of structural steel.

Local features as to topography and the nature of the traffic to be served largely govern this type of structure. All local traffic from Suncook will be served by the present highway. Any

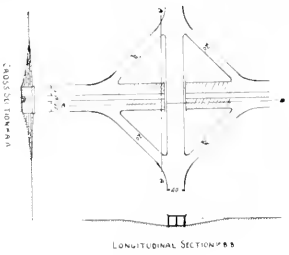

FIG. 3.

north bound traffic from route 28 will be served by Turnpike St. Southbound traffic route 28 will cross the river on the lower level and come on the highway on the ramp at the right of the south bridge approach. Traffic from route 3 to route 28 will leave the main highway by the other ramp and cross the river on the lower level.

Only by rigid adherence to universal grade separations at all intersecting highways can traffic be passed straight through Queens without a stop. The three main high-speed arteries involve 24 miles of route in Queensborough. They connect Manhattan, Brooklyn, and the Bronx, through Queens, with Nassau County and other territory to the east of the New York City line on Long Island. There are 78 bridges in this system of which 19 are in the Interborough Parkway System, 15 in the Grand Central, 3 east of Kew Gardens, 12 in the northerly extension of Grand Central Parkway, 11 in Astoria Boulevard, and 11 in Sunrise Highway.

Several designs have been used from the conventional clover leaf to elaborate layouts of service roads, etc. Usually it is easy to drop a center road and pass under an intersecting highway where plenty of space is available. This requires 150 to 160 feet or more. Rarely can this be done in the city without tremendous expense for condemnation of the requisite land and structures.

Several of the crossings illustrated as showing the different methods im-

posed largely by topographical or local conditions, will be described briefly. These are from the Grand Central Parkway System because it is most nearly completed.

Half of its crossings and bridges have been completed and all the others are in various stages of progress. Its grading is substantially finished, and paving is scheduled for completion during this winter. Its contour is gently undulating, rising from 73 feet at Queens Boulevard to 251 feet about 6½ miles east.

The simplest of all crossings are those that provide no immediate connection between the intersecting roads. This is the case where Grand Central crosses Midland Parkway. There is only a single set of ramps, midway between 164th and 168th St., to serve both these crossings. This section of one mile has three direct crossings, at intervals of 1,700 and 2,300 feet with one bridge and 12 ramps or other connections between the main and service roadways. There is only one direct access between the express route and the three intersecting highways but intercommunication is established by means of the service roads.

One of the simplest connections on all the routes is that at the crossings of 164th and 168th Sts., 1,500 feet apart with Grand Central Parkway. Access is had readily by way of the two service roads through off and on ramps. The ramps are only 60 feet long because the grades of the road are carefully designed.

A different arrangement of ramps, accompanied by the only deliberate "turn-around" in the whole route, appears at Cross Island Boulevard and the entrance into Hillside Park. On the north side of the parkway, the connection is direct with the boulevard, hence the ramps are given the requisite length (one is more than 550 feet) to overcome the difference in level without troublesome grades. On the south side a shorter ramp is possible as the connection is with the service road and that in turn overcomes a part of the grade difference. To the west of this crossing is a bifurcation of the parkway with short turn-around access roads for traffic in each direction. This not only permits cars to retrace their routes but also allows access from both directions.

Here in Chicago is located a complete clover leaf layout. The state highway Commission, in conjunction with the Lincoln Park Commissioners, has constructed a mile of road extending from Montrose to Foster at an estimated cost of $500,000. The layout consists of four cloverleafs and an adjoining service parallel to the main road. An example of thought toward future building can be seen in the fourth ramp at Foster avenue. The roadway ends here and there is no need for a ramp at the present time, but plans for the future call for an extension of the system. To provide for this the turnoff at Foster was built where the future ramp will go, thereby preventing future tearing up.

Superchargers

By J. H. DE BOO

THE object of supercharging is to force into and burn in each cylinder during each cycle, a greater amount of charge than can be drawn in by the normal pumping action of the cylinder and piston, in the time available, thus liberating an amount of heat greater than would be normally possible and thereby increasing the power output of the engine without increasing the cylinder volume.

Four types of pumps have been used, namely, piston, vane, Roots' blower and the turbo-compressor. Of these the Roots' blower has proved most adaptable and is extensively used in airplane and racing engines.

The idea of supplying the carburetor with air at above atmospheric pressure is more than thirty-two years old, as indicated by some old French patent specifications of Renault, dated 1902. These early attempts were abandoned and the next record of an attempt to use it was made in the United States. This was done in Chicago where supercharging was applied to a four cycle engine, belted to a Connersville blower, rigged up and tested in 1911. The blower, which was the smallest Connersville type available ran at the same speed as the engine and was so connected that gas from the curburetor to the engine could pass through the blower or around it, depending upon the opening of the angle valves. A prony brake absorbed the load, but because of the engine's great speed with the supercharger working and the excessive vibration, standard scales could not be used for weighing the load. Therefore a known weight which could not be raised without the blower in operation, was attached to the brake lever and when the speed increased, the weight would be raised, showing that horsepower increased faster than the speed.

During the world war, owing to the necessity of building fighting planes of light weight and high speed for pursuit and combat purposes, the problem involved in the designing of an engine capable of operating efficiently in rarified atmosphere (without a reduction of power output), became one of great importance. In each of the belligerent countries, intensive investigations were made. The research work in the United States, as made by the De

Editor's Note: J. H. DeBoo, a senior in the department of Mechanical Engineering, has compiled this article from several others on the same subject.

Laval Steam Turbine Company and by the General Electric Company, dealt exclusively with the employment of a high-speed centrifugal compressor either by a crankshaft through a speed increasing gear, or by an exhaust gas turbine, and directed the attention of engineers to the application of supercharging in cases where greatly increased power per unit of cylinder volume was required.

After the war, enterprising designers of racing car engines applied supercharging to racing engines. In 1922, the Fiat Company successfully built the first supercharged engines in which a rotary supercharger driven directly by the crankshaft was employed. Following the Fiat example, the other leading motor firms entered supercharger equipped cars in the International Races the next year.

From the first conception of the supercharging idea, namely to obviate high speeds, it was only a logical development to employ intake pressures several pounds per square inch in excess of atmospheric and thus fill the cylinders with a considerably greater weight of charge. At the same time, the first attempts were made to employ superchargers in touring cars and in Diesel engines for marine use.

The thermodynamic fundamentals are similar for all types of supercharged engines. In dealing with the graphical method of representing the work done during the engine cycle, the cycle is shown on the T-S (temperature-entropy) diagram. (Fig. 1.) By this method the thermal efficiency of the cycle may be easily obtained as a ratio of the Btu converted into work (area of cycle) to the total heat of the charge liberated in the cylinder.

$$\text{Thermal Efficiency} = \frac{\text{Work done in Btu}}{\text{Total heat of charge freed in cyl.}}$$

In order to take account of the variation of the specific heat of the gases due to the changes of temperature corresponding to the different phases of the cycle, the gas entropy chart of Stodole is used. In order to more closely approach the actual conditions, the ideal diagram, composed of two adiabatic curves BC and AD and two constant volume curves AB and CD, will be modified as follows: corners corresponding to the beginning of expansion, to the advanced ignition and to the exhaust (beginning of), will be rounded off, points A, D and C respectively. The heat conducted away by the cylinder walls and by the cooling water is also taken into account, and based on experiments, the assumption is made that 80-85% of the heat liberated at the end of compression actu-

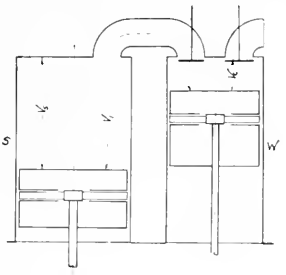

Fig. 1.

ally remains in the gas while the rest can be considered as given up to the cylinder walls and cooling water.

The differences due to the imperfection of the gas are neglected while the effect of dissociation at the high temperatures of the burnt gases is not considered in the calculation at all. The plotting of the cycle, on the T-S plane requires as with the steam engine cycle, the finding of the entropies corresponding to temperatures at the vital points shown (A, B, C, D) and also the finding of entropies for intermediate points in order to obtain a fairly accurate representation of the cycle.

Supercharging may be affected by forced induction, supplemented induction, scavenging or two-stroke operation. In the forced induction engine, the whole charge is supplied to the cylinder at a pressure higher than atmospheric by means of a special pump, and sometimes a receiver is placed between the pump and the cylinder. In order to reduce the pumping work and the size of the pump, most of the charge may be drawn into the cylinder in the normal way, the action being supplemented by a special pump. The chief objection to the plan lies in the combination of the necessary valves and their timing.

By employing a pump to compress air to a pressure slightly above atmospheric, all the residual gas in the combustion chamber may be swept out at the end of the exhaust stroke. A greater amount of charge can be then drawn into the cylinder by the normal pumping action of the engine, particularly since the cylinder walls are cooled by the scavenging air. This also permits the use of a higher compression ratio.

In a two-stroke engine, a charge pump is required in any case and supercharging can be affected simply by enlarging the charge pump capacity. One objection to this method of operation is that a considerable per cent of the full charge would escape or be forced out of the exhaust port. Because of the waste of fuel during the scavenging process, scavenging is often done by means of air compressed in the crankcase and a separate pump employed to force in the combustible charge.

The Root's blower has been used successfully for supercharging on racing engines by Mercedes, Vauxhall, Talbot, Sunbeam, and Alpha-Romeo. The turbo-compressor was developed by Rateau, in France, and by Moss, in our own country, at about the same time. At present, the most successful type of blower developed for racing car supercharging is the turbo-compressor as used by Duesenberg and Miller.

While the only true method of investigational performance of supercharger equipped engines is by actual test, still it is possible and very desirable to be able to predict by preliminary calculation the performance of a supercharged engine. In a test undertaken by the navy department the calculations were checked by an actual

test made on a type 12 D Curtiss airplane engine, supercharger equipped, installed in the altitude chambers of the bureau of Standards.

Thus we can outline a method of predicting the horsepower available at all altitudes from an engine equipped with a direct driven geared centrifugal supercharger to compare with the result that can be expected from the same engine when equipped with superchargers of different altitude ratings and to present an actual performance check on one of the engine supercharger combinations.

Although a gear driven supercharger is capable of maintaining sea-level pressure in the intake manifold up to a certain maximum altitude, the horsepower available from the engine is not constant up to this point. Several factors contribute to a reduction in power output at the lesser altitudes even when constant inlet pressure is maintained by supercharger. The most important of these factors are the horsepower required to drive the supercharger, reduction in the charge density due to heating of air in supercharger, variation in the mean effective pressure due to the difference between the exhaust pressure and intake pressure, and variations in the speed of the engine due to variation in the propeller characteristics with density, airplane altitude, and speed. During the climb or ascent the last mentioned has greatest effect.

Above the altitude called for by the supercharger rating, the intake manifold pressure decreases, thus cutting down horsepower output of engine. As a result of these factors the supercharged engine in the airplane at the above rated altitude gives less power than an unsupercharged engine would give at sea-level. Under the same circumstances, however, that is at same altitude the advantage would be with the supercharger-equipped engine. As the altitude increases from sea level up to the maximum allowable according to the rating, the power output increases until, due to the rarefied state of the air, the supercharger can no longer maintain sea-level pressure in intake manifold. This point marks the top altitude limit for that engine. If the airplane is forced higher there is a rapid falling off of power. By choosing an average rating, it is possible to secure a supercharger which will not cut down power too much for low altitudes, and at the same time give an increase of power as the altitude increases to the top limit.

This rating cannot be calculated but it can be fairly accurately approximated by careful consultation of a set of curves which indicate the power available at all altitudes with superchargers of various ratings.

Such factors as weight, compactness, mechanical reliability, etc., also enter into the selection of the best average rating. Experiments were made with two types of superchargers: one a 20,000 foot supercharger with air cooler and carburetor on the pressure side of the supercharger; and a 7500 foot su-

percharger without air cooler having a carburetor on suction side of supercharger. Neither test proved sufficiently reliable from a mechanical point of view to be considered a satisfactory solution of the problem but very good results were obtained by combining the best features of each system.

The air cooler type (pressure carburetor) gives the greatest output of power, but means more weight, complications, and larger frontal area, in addition to greater possibility of backfiring. Thus the suction carburetor system is more desirable because of its simplicity, compactness, and fuel economy. The main difficulty in the development of a satisfactory gear-driven superrharger lies in providing a light, high-speed gear train of sufficient strength to withstand the sudden acceleration forced upon the drive by crankshaft torsional vibration. This difficulty varies directly with altitude rating since the latter also varies directly as does the effective inertia of the propeller.

In order to ascertain the power output of a particular supercharger and engine combination at any given altitude and speed, it is necessary to determine first the characteristics of the supercharger. Then the horsepower needed to run the supercharger can be calculated, as well as the temperature and pressure rise. The condition in the inlet and exhaust manifold are then determined. From the data, the power output of the engine can be calculated on the basis of reasonable assumptions as to the effect of manifold conditions on the power developed.

The following are some illustrations of the method of computation. To calculate the temperature rise and the horsepower input for a given supercharger rating and efficiency:

$$\text{H.P.} = \frac{3.44\ WRT_1\left[\left(\frac{P_2}{P_1}\right)^{0.219} - 1\right]}{33{,}000\ E}$$

where

W = weight of fuel consumed / min.

R = gas constant

T_1 = initial state temperature

E = efficiency of supercharger

p_1 and p_2 = pressures before and after temp. change, respectively adiabatic rise in temp. $= \triangle T_a = \left[\left(\frac{P_2}{P_1}\right)^{0.291} - 1\right] T_1$

actual temp. rise $= \triangle T = \frac{\triangle T_a}{E}$

In calculating the horsepower input and the compression ratio for a given supercharger at other than rated condition, use is made of the fact that, over the range during which the efficiency is about constant, the temperature rise depends on speed only varying as its second power.

$$\frac{\triangle T_2}{\triangle T_1} = \frac{N_2^2}{N_1^2} \text{ or } \triangle T_2 = \triangle T_1\left(\frac{N_2}{N_1}\right)^2$$

In computing the corresponding pressure ratio, the adiabatic temperature rise is used.

$$\triangle T_a = \triangle T(E)$$

$$\frac{P_2}{P_1} = \left(\frac{T_1 + \triangle T_a}{T_1}\right)^{3.44}$$

The supercharger horsepower input

under the new conditions is obtained by correcting the input under the rated conditions.

$$\frac{HP_2}{HP_1} = \frac{N_2^3}{N_1^3}\left(\frac{d_2}{d_1}\right) \text{ or}$$

$HP_2 = HP_1 \left(\frac{N_2}{N_1}\right)^3 \frac{d_2}{d_1}$ where d is density of air entering supercharger.

The normal sea-level indicated horsepower is found by diving the normal BHP (100) by the mechanical efficiency which was 88.7% for the engine tested.

The value is corrected for the intake manifold pressure by multiplying by the supercharged inlet-manifold pressure and dividing by the unsupercharged inlet manifold pressure (28.4" Hg) assuming a pressure drop in carburetor of 1.5" Hg.

The temperature correction is then made by multiplying the I.H.P. as corrected for pressure by the square root of the ratio of the standard sea-level absolute temperature (519° F) to the intake manifold temperature.

The increase in power due to the reduced back-pressure is computed from the following relation.

$$\text{HP correction} = \frac{(P_1 - P_E)\,(P_1 D_1)\,(N)}{792{,}000},$$

where P_1 = inlet-manifold pressure and P_E = exhaust manifold pressure.

The correction factor for increased charge takes the form of a multiplying factor that is applied to the IHP (corrected for pressure and temperature).

$F = \frac{1}{R-1}\left(\frac{P_1 - P_E}{P_1}\right)$ where R = compression ratio.

The explanation of the operation of the supercharger is greatly simplified by the addition of a diagram showing the combination of the supercharger and engine (Fig. 2). The power cylinder W is shown with its piston at the beginning of induction stroke. The supercharger S is shown as a piston pump having swept a volume greater than that of the working cylinder and is shown in a position ready to deliver a charge to the working cylinder, W. The pressure throughout the system is that of the surrounding atmosphere P_a. The supercharger may be arranged to discharge into some form of receiver and maintain therein a more or less constant pressure, but regardless of what system is adopted, the arrangement is fundamentally the same as is shown in the diagram. The piston type of compressor is chosen for illustration of the principle of supercharging because it gives a much clearer concep-

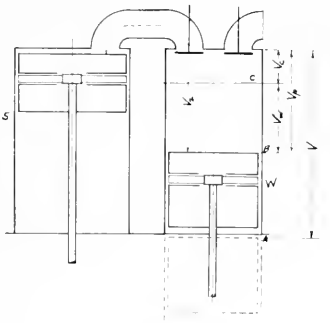

Fig. 2.

tion of the operation than any form of rotary compressor would.

The initial volume of the whole system V_1 is the sum of V_s, the swept volume of the supercharger; V_c, the volume of the combustion space and the necessary clearance in the connecting passages.

As the piston of the working cylinder moves outward, that of the supercharger moves inward, transferring its charge to the working cylinder. At the end of their respective strokes, the position of the two pistons are shown in Figure 2. The volume V_2 now is the sum of V_w, the swept volume of the working piston; and V_c, the volume of combustion space plus clearance space in passages.

The clearance volume has no effect on the thermodynamics of the engine, if it is assumed that the intake valve of the supercharger is not opened on the return stroke until the pressure within it has fallen to that of the outside air. The work of compressing the gas which remains in the clearance and passages will then be returned and may therefore be neglected, and only that work taken into account which is done on the gas actually passing into the working cylinder. The only effect of clearance is the necessity of increasing the size of cylinder S by a volume proportional to the size of clearance volume and to the supercharger compression ratio.

As the supercharger has a greater swept volume than that of the working cylinder, V_1 will be greater than V_2, and pressure P_s, after induction, will be greater than P_a. By the ordinary compression pressure equation we get

(1) $\frac{P_s}{P_a} = (V_1/V_2)^2$ or $P_s = P_a(V_1/V_2)^2 = P_a(R_s)^2$ where $R_s = V_1/V_2$ supercharger compression ratio.

A little thought shows that for the same initial pressure P_a, R_s also equals the ratio between the weight of charge which has been introduced into the working cylinder and that which would have been drawn into the same cylinder if supercharging had not been used.

The intake valve of the working cylinder now closes and compression occurs on the return stroke as in the ordinary Otto cycle engine, with the important exception that the starting point of compression will be P_s instead of Pa, and the final compression pressure will be greater than that which would result from the same initial and final volumes in an ordinary engine. From the usual equation, the compression ratio will be

(2) $P_c/P_s = (V_c/V_p)^2$ or $P_c = P_s(V_c/V_p)^2 = P_s(R_w)^2$, where V_p is the total volume of working cylinder, R_w is the compression ratio of working cylinder. Substituting for P_s in (1) we have

$P_c = P_a(R_s)^2(R_w)^2 = P_a(R_sR_w)^2 = P_a(R_c)^2$ where R_c = total compression ratio to which the gas has been subjected.

The final result, with regard to the compression, is as if the piston of the working cylinder had started to compress the mixture at atmospheric pressure from a point farther down the

cylinder as shown in fig. 2, where B is the actual starting point, and A is the position from which it would have to start to produce the same ultimate compression as has been produced with the supercharger. Then if V is the total volume corresponding to point A, and V_p = the true volume of working cylinder, then $V - V_p$ will equal the amount of additional charge which has been added by the supercharger and V/V_p will be the supercharger ratio R_s.

Since the piston of the working cylinder works only between V_c and V_p, the expansion ratio R_e will be V_p/V_c, that is, the same as the compression ratio within the working cylinder. We have thus an engine which has a true compression ratio greater than the expansion ratio.

Until recently the supercharger principle has been applied only to airplane and racing auto engines, but its applications to engines of passenger cars is now in process. Fred Duesenberg, head of the Duesenberg Motor firm, has been consistently successful with building and racing of supercharged engines. He advocates an electrically driven supercharger which will run at constant speed regardless of engine speed. Such a unit would have greatest effect at low speeds, and then mainly in the way of better atomization and distribution of the fuel. By this means an engine with manifolds, valve size and timing designed for low speed (passenger and commercial car) use, is converted into an engine of great power, efficiency and flexibility.

In a German test application with a Mercedes six cylinder engine, bore 3.15 inches, stroke 5.118 inches and compression ratio 5.4 to 1, using the German fuel consisting of blended benzol and gasoline, a maximum speed of 55 to 60 mph was obtained without the supercharger, while up to 90 mph was obtained when supercharger equipped.

Supercharging is introduced at moderate speeds (about 30 mph). Below this point the engine is a very efficient low speed unit, but above this speed, because of the supercharger which overcomes the drawbacks of small manifolds and valves, the power curve goes up to a peak of about 100 hp. at 3000 rpm. On this engine, a Root's blower type supercharger is driven through a clutch and gear train from the front end of the crankshaft, being engaged by travel of the accelerator pedal beyond the normal full throttle opening.

About 10 hp. are required for driving the supercharger at 300 rpm. The gain in power is about 54% above that of a normal high speed engine of equal displacement. Due to the supercharging action, volumetric efficiency is practically 100% at high speeds and the compression ratio is 7.3 to 1. In practically every phase of operation, this engine shows its advantages.

THE ARMOUR ENGINEER

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Athletic Support

DURING the various seasons of the year, some few of the prospective engineers enrolled at the Institute take enough time from their studies to practice for participation in the several lines of sport endorsed by the school. In all of these fields, the men, although handicapped by the strenuous curriculum, have always given the strongest of opposition to any and all opponents.

The question is, are these teams appreciated? The men participate through love of the sport, but it is gratifying to have a few friends on the sidelines doing their bit in the way of pulling for victory. There has been much evidence of the fact that the men not in participation do not care to take the necessary time from their somewhat crowded schedule to see whether the athletes make a creditable showing or not.

Let us back our athletic teams in the manner they deserve.

THE GUEST EDITORIAL

Engineering Frontiers

THOSE Armour students who accepted the opportunity given by Professor Schommer and the Faculty Club on December 19, saw mirrored in the camera a record that spanned millenniums of time, and showed man's continuing success in penetrating beyond paradoxically forbidding and alluring frontiers.

From the prehistoric time when development of that now magic machine, the human hand, began, to our own day of radio, streamlines, and aeronautics, frontiers one after another have been left behind. Hazards which the frontier has placed in the way of man's advance have, at different times, taken on every conceivable aspect and have taxed every visible and hidden resource in man's being. Whether the conquest of frontiers has been made literally in a geographical sense, or merely in acquiring some new mastery over environment, it has always been attended with the devising of new instruments and new techniques for overcoming difficulties.

As the number and complexity of his contrivances have increased and the radius of their potency has lengthened, man has perforce become more and more a social animal; more and more he has had to join with his fellows both in his plans for utilizing the machines he creates and in organizing the work necessary for those creations. The curiosity, inventiveness, and power of reflective thought which make possible the mastery of science, technique, and organization required to construct and navigate airplanes are the same basic qualities that must be marshalled in devising a reasonable plan of living in a world of which the airplane is a symbol. It would be laboring an obvious point to stress the fact that the rapid multiplication of technical aids to living create similar possibilities of acceleration and give rise to similar necessity for control in organized society as are present in the machines themselves.

The engineering frontier today, then, is at the same time a social, economic, and political frontier. Transmission of light, sound, and power; improving the transport of persons and freight; facilitating the movement of traffic of every kind; making houses sanitary, decent, comfortable, and convenient—these and a multitude of other items present problems which the engineer today is helping to solve and to which the engineer of tomorrow will make even larger contributions. And so the engineering frontier presents in modern guise the same challenge which receding frontiers have always offered to man's progress.

WILLARD E. HOTCHKISS
President

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

The Electrical Properties of Glass

By Littleton and Morey

John Wiley & Sons

GLASS as an electrical insulator has been employed for many years, but in recent times new glasses have been developed with properties which make them even more useful for that purpose. Writings on the subject, however, have not kept pace with these developments, for little or no attempt has been made to collect and review the available information relating to the electrical properties of glass. This book presents a summary of our present knowledge as to these properties, and is intended mainly as a work of reference for laboratory workers interested in electrical measurements and dielectric theory. Some attention, however, has been paid by the authors to the use of glass as an engineering material, and the book will therefore be of interest to insulation engineers and students.

The first chapter is devoted to a discussion of the general properties of glass, including such subjects as its density, elasticity, strength, and specific heat. The common methods of manufacture and the chemical composition of the various glasses are discussed with a view of giving the reader a better understanding of the subject in general. In the second chapter is taken up the electrical conductivity of glass, with reference to surface and volume conductivity, methods of measurement, and the effect of temperature. The determination of and factors affecting the dielectric constant, power loss, and dielectric strength constitute the remainder of the volume.

Throughout the book the authors have attempted to promote an interest in further research in the subject by emphasizing the lack of existing knowledge. Extensive graphs and tables increase the usefulness and clearness of the text.

Marine Aircraft Design

By William Munro

Sir Isaac Pitman & Sons, London

MANY books have been written on the subject of general airplane design, but very little literature is available concerning the design of

marine aircraft from a practical standpoint. The author of this volume has endeavoured to discuss the fundamentals of the design and construction of such planes without overlapping the existing books on aeronautical engineering.

Weights of aircraft from three thousand to twenty thousand pounds for boat seaplanes, and fifteen hundred to five thousand pounds for the float type, constitute the range discussed, but for the sake of clearness the calculations given throughout the book are for one size only.

In general the subject matter included in the text may be divided into two sections, boat and float seaplanes. With reference to the former, various general considerations in the construction of the craft are discussed, such as the determination of the center of gravity, diameter of the propeller, position of the pilot, and the like. Several chapters are devoted to the hull design, together with the analysis of stresses in them and the actual methods and types of construction. Methods of stabilizing the flying boat and the design of the wings are included. In the discussion of float seaplanes, general considerations in design are likewise given, as well as an analysis of the various factors which enter into the calculations. The author also takes up the different types of construction of the floats for both regular and racing planes, and discusses the stress analysis of a commercial seaplane float chassis.

The volume contains numerous illustrations of existing seaplanes, as well as useful data sheets, tables, and graphs.

The Book of Stainless Steel

Edited by Ernest E. Thum
American Society for Steel Treating
Cleveland, Ohio

SOME of the main objections to the use of common steel are that it rusts in air, corrodes in the presence of acid, and scales at comparatively low temperatures. It is mainly for the purpose of obviating one or more of these objections that stainless or alloyed steels are employed. The usefulness and method of working them, however, vary with the different constituents, and the book, therefore, endeavours to discuss this subject in detail.

The subject matter included in the volume is divided into four main sections, the first of which takes up the production and fabrication of stainless steel and its products. Under this heading is given a short historical account of the development of stainless steels, general requirements of the alloys, and an analysis of the problems of melting and casting. There is also included a description of the various methods of rolling and forming the metal, different types of welding, and plating with chromium.

In the second section is taken up the properties of the typical stainless

steel alloys, such as the five percent chromium steels, low and high carbon steels, chromium ferrites, and higher alloys of chromium, nickel, and iron. Under each of these headings the uses, properties, and methods of manufacture are given. A discussion of the requirements of the industries which make use of stainless steels constitutes the third section of the book. The fourth part is devoted to a description of the stainless, acid and heat resisting alloys which are manufactured in America.

Each of the chapters in the book has been written by a different author, all of them authorities on their subject through work in that field. The volume contains many illustrations and graphs.

Dynamics of Earthquake Resistant Structures

By Jacob J. Creskoff

McGraw-Hill Book Company

THERE is probably no portion of the United States which is not subject to some form of earthquake shock. The author shows this very clearly in his opening chapter. In view of this fact, and inasmuch as the added cost of making buildings quake-proof rarely exceeds ten per cent, the author terms the neglect to do so in the larger and more important buildings a "questionable practice." He approaches the subject from an entirely new angle, for he discusses aseismic design from the standpoint of dynamical and not statical theory. In so doing several of the paradoxes which arise in the statical design are cleared up.

In the first few chapters a general discussion of earthquakes, their causes, and measurement of their effects is given. This includes an analysis of the seismic motion of a particle. Subsequent chapters take up the relation of earthquakes to the deflection and vibration of beams. Application of this theory to the design of buildings, and the solution of two typical problems, involving a low and high structure, are also discussed.

The reading matter in the text is reduced to a minimum, and the basic principles are given in a concise manner. Most of the formulas are derived, so that the underlying theory is given in each case.

THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Basketball

THE Armour Tech basketball season was started off in fine style. The first game, played with South Side Junior College, was won by a large score. George Williams, Wheaton, and the University of Chicago were the next victims on the schedule. In the Chicago game the boys put out what was probably their best game of the season to prove their superiority over their Big Ten opponents. The first defeat came shortly after this, with the team losing a close game at Lake Forest College. Armour promptly turned the tables by handing Lake Forest a 41-33 defeat at the armory in the return engagement. Michigan State Normal with their formidable looking team was in turn defeated by a 33-25 score. North Central gave the boys their second setback in eight games to the tune of 28-22.

Heike, Merz, and Lauchiskis have been the high scorers for Tech so far this season, while Obrien, Warner, Christoph, Doane, and Dollenmaier have all been doing their part. Capt. Lauchiskis was out of the lineup with an injured knee the first part of the season, but now he is back and functioning as well as ever.

The fact that the games are now being played closer to school, at the armory on Wentworth avenue, has brought larger crowds out for the games. This is a good sign, for the team has more spirit when it has some backing. Let's have more of this spirit and we will have the best team in years.

ARMOUR TRIMMING CHICAGO

Swimming

The Tech tankers splashed their way to a 40-35 victory over South Side Junior College. That started the season off with a bang. The team has been working hard at the practices held at Bartlett pool. As in the past, this season's schedule is again a tough one. In order to finish it with a good record the boys will have to do their best every minute they are in the pool. If there were better crowds out for the meets, the boys would undoubtedly be encouraged to do even better than they have.

Fencing

The Armour fencers have been improving as they go along. Under the able direction of Professor Hans Fischer the boys have been able to increase their knowledge of how to handle the foil. A definite schedule has not been made out as yet, but as soon as the team is more organized meets will be arranged with such schools as Northwestern, Chicago, Illinois, and Michigan State. All men who are interested in fencing should see Professor Fischer about coming out for the team.

Track

Track practice is under full swing now as the season is well under way. The boys under the supervision of Coach A. A. Stagg have rounded into the condition which is necessary for the strenuous schedule this season.

The interclass track meet was held on January 14, with the freshmen nosing out the second place seniors, 58-53½. This is very promising in that there is some good talent in the freshman class. A constant supply of material is necessary for a winning team, and this fine showing made by the freshman makes the outlook bright.

The Armour Invitational relays will be held on March 16 at the Chicago University fieldhouse. This is by far the most important event on Armour's schedule. A big student turnout for this event is essential to its success.

The mainstays of this year's team are Capt. Roberts, Neal, Carroll, Hevrdejs, Concolino. It is not too late to go out for the team, so any men interested should see John Roberts.

Tau Beta Pi

The following men were initiated into Tau Beta Pi on November 21, 1934, after having served a pledgeship of two months:

L. W. Biegler
J. H. De Boo
O. P. Freilinger
J. F. Humiston
J. O. Larson
J. K. Morrison
G. A. Nelson
J. M. O'Connor
W. A. Trudelle
H. J. Zibble
J. C. Witl

The initiation was held in the faculty reading room, and was followed

by a banquet in the Faculty Grill. After the banquet the entire group adjourned to the Grand Opera House to see "As Thousands Cheer."

Mr. J. C. Witl, chemical engineer and director of research at the Universal Atlas Cement Corporation, and one of the initiates, is a graduate of Armour.

Salamander

The Salamander initiation was held at the Phi Kappa Sigma house. Among the guests were J. V. Parker, J. B. Finnegan, C. P. Holmes, O. L. Robinson, K. H. Parker, Fitzhugh Taylor, R. M. Beckwith, R. O. Matson, H. J. Bannasch, J. T. Even, and C. B. Herbst.

The men who were honored by iniatiation had been pledged several months ago.

Eta Kappa Nu

Eta Kappa Nu held its initiation banquet at the Medinah Club on December 4, 1934. After they had demonstrated the profound character of their knowledge, the following men were initiated:

G. C. Galbraith, '35
Walter M. Uzunaris, '35
Victor J. Kropf, '36
Norman Cooper, '35

The program included wrestling, piano accordion numbers, and a talk by Prof. John J. Schommer. There were about sixty active and alumni members present.

Eta Kappa Nu Banquet

Chi Epsilon

Chi Epsilon, honorary civil engineering fraternity, initiated three pledges on the evening of January 9, 1935. The men initiated were:

A. Lester, '35
B. Rigoni, '35
R. R. Johnson, '36

The initiation was conducted in the club rooms and was followed by a dinner in the Terrace Gardens of the Morrison Hotel. Dean Heald and Professors Penn and Ensz were present. The dinner and entertainment were enjoyed by all.

American Institute of Chemical Engineers

The results of a survey of the members to determine their preference of subjects for discussion showed that a considerable number of them were interested in food chemistry, legal aspects of chemical engineering, the rare metals, paper chemistry, etc. Following the policy of giving our members

what they want, on November 23, Carl S. Miner, chief director of Miner Laboratories, gave a talk on "The Chemical Engineer on the Witness Stand." Other speakers who will be at meetings in the near future are: J. O. Clarke of the Food & Drug Administration; Dr. C. W. Balke, head of research of Fansteel Products Co.; Dr. L. M. Tolman, chief director of research of Wilson & Co., and others.

Other plans for the future are the annual smoker and a Junior-Senior debate on the subject: "The Value of a Graduate Degree."

American Institute of Electrical Engineers

The officers of the society for the ensuing year are as follows:

Louis F. Higgins.....Chairman
Alfred Auge .....Vice-Chairman
Lawrence Cullen .....Treasurer
Albert Petraitus.....Secretary

Mr. Auge, permanent chairman of the program committee, has great plans in store for the members. At past meetings pictures secured from the Illinois Bell Telephone Co. were shown, and several prominent speakers were featured, including Mr. W. H. Horsch of the Union Switch and Signal Company.

Western Society of Engineers

On the night of December 15, the Armour branch of the W. S. E. held their first smoker of the year. The event was well attended by the faculty and members. The atmosphere was that of a Monte Carlo Casino with roulette, keno, craps, and blackjack games provided for amusement. Stage money was used and a prize awarded to the man holding the most money at the end of the evening. Prizes were won by Hanson, West, and Bolton.

In the near future a moving picture on the construction of the Boulder Dam is to be presented at a general assembly, under the auspices of the W. S. E. This film was secured from the Southern Pacific Railroad by Dean Heald.

American Society of Mechanical Engineers

This year the Armour chapter of the A. S. M. E. has established a record in its membership in the Student Branch of the American Society of Mechanical Engineers, with over fifty members belonging to that organization. The meetings held thus far have been given over chiefly to the presentation of talks by student speakers. These speakers are entered in a competition for the position of official delegate to the annual Student Branch council meeting, which will be held this year on April 29 and 30. The delegate chosen will present his paper before the convention in a contest for fifty, twenty-five, and ten dollar prizes offered. Some very interesting and well presented talks have been given so far, and it is hoped that Armour may win a prize this year.

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF THE AUTHORS AND PUBLISHERS

Watching the Watchman

J. J. Ryan and F. Shaw

(From The Electrical Journal, Nov., 1934)

THE equivalent of the adage "watching the watchman" recently cropped up as a problem in the design of an ingenious new electrical appliance. The watchman is a new automatic fire alarm appliance that can be plugged into an ordinary 115 volt, 60 cycle socket. A tiny neon glow lamp is the unit that keeps an eye on the watchman.

An automatic fire alarm unit obviously must be extremely reliable and ready to detect a fire at any time. Practically all previous forms of automatic fire-alarm units, within reach of the average home owner, were fixed thermostats set to trip an alarm at some predetermined temperature. It is necessary to set the fixed thermostat to operate at a fairly high temperature to avoid false alarms. Thus a fire would be fairly well started before it could be detected. When a mechanical spring was used to operate the alarm, it was only a matter of time before it became clogged or rusted from the dust and moisture of the average residence cellar. Where dry cells are used to energize the alarm, forgetfulness and neglect on the part of the building owner frequently placed this old style alarm unit out of commission and created the added hazard of a false sense of security.

The new fire-alarm combines the two best principles of automatic fire alarm and a loud howler in one unit. The first principle uses the rate-of-rise thermostat and the second, the fixed thermostat. The rate-of-rise thermostat will not cause false alarms from the ordinary heating of a building, but it is quick to catch a blaze in its early stages. It will sound an alarm within a minute or two following a rise of 15° to 20° F from the prevailing room temperature.

The rate-of-rise thermostat is a cylindrical air chamber, one end being a thin metallic diaphragm, about .001 inch in thickness. A small opening in this diaphragm allows expanding air to escape when the temperature increase is less than 15° to 20° F a minute, outside the chamber. When the rate of rise is higher, air in the chamber expands faster than it can escape and the pressure causes the diaphragm to bulge outward, closing an electrical contact that sets off the howler. As the temperature drops in the air chamber or equalizes with the room, the

diaphragm drops to normal position shutting off the howler.

To make the fire-alarm unit even more reliable, the bimetallic, fixed thermostat is added so that, should a slow smoldering fire cause the temperature to rise too slowly to operate the rate-of-rise rheostat, it would be detected by the fixed thermostat at 150 F. Neither detecting unit requires renewing after operation.

It is desirable to provide some means of indicating at all times that the unit is in operating condition. Whatever is used must have a low power consumption, a long life, and small initial cost. A neon lamp which requires .75 watts is used in a candelabra socket with the necessary resistance placed external to the lamp. The lamp requires a series resistance of 50,000 ohms. It operates on 110 to 120 volt alternating current, but will glow at 85 volts A.C., or 110 volts D.C.

Rotary Pumps

W. E. Bakewell

(From Power, Nov., 1934)

ROTARY pumps superficially resemble the centrifugal type but are more like the reciprocating pumps in that they both are of the positive displacement type. These pumps combine the constant-discharge characteristics of the centrifugal pumps with the positive-discharge of the reciprocating types.

The advantages of rotary over reciprocating pumps are: they deliver a continuous flow, free from pulsations; are simpler in construction; smaller in size for equal capacity; and, cost less to install and maintain. They can handle any liquid from tar and pitch to gasoline and benzine, provided that liquids are free from gritty and abrasive materials. Abrasive materials cause excessive wear which destroys the seal between rotating members and the housing which permits leakage losses and reduces volumetric efficiencies.

These pumps are self-priming and are capable of operating against a suction lift of 25 feet or more. Rotary pumps with take-down features are adapted to uses where frequent cleaning is necessary, as in creameries.

Originally it was thought that rotary pumps were applicable only to low pressures, less than 100 lbs. They can be used for high pressures if properly designed. Roller or ball bearings are customarily used. These are mounted outside the pump, out of contact with the liquid being pumped.

Effeciencies compare favorably with other types of pumps. The maximum effeciency is 85%, at pressures ranging 250 to 300 pounds. Beyond these pressures the effeciency falls off due to increased slip and friction. These pumps cannot operate against a closed discharge, unless an automatic unloader is provided; the pressure builds up until the pump casing breaks, or the driving motor is shut off by an overload device.

Metals and Alloys in Dentistry

By O. E. Herder

(From Metals and Alloys, Nov., 1934)

DENTISTRY is one of the chief consumers of the precious metals; annual figures usually show that more palladium is used by dentists than by any other industry. The alloys developed have a wide range of properties, the tensile strength ranging from 15,000 lbs. per sq. in. for pure gold to 200,000 lbs. per sq. in. of cast and wrought gold alloys. Some of these high tensile strength alloys contain gold, copper, silver, platinum, palladium, nickel, and zinc.

The use of metals for dental purposes dates back to antiquity. It has been reported that the teeth of Egyptian mummies have been filled with gold. An author reports that the use of gold for filling dates as far back as 1500 B. C. The Romans used lead to fill cavities. The use of gold leaf for this purpose is traced back to the 15th century, and the use of silver foil to the 17th century. The use of gold foil for inlays was introduced into the United States in 1795 by Wolfendale who obtained the foil from England. The foil was rolled into a cylinder, wedged into the cavity, and hammered until it filled the hole.

The use of gold foil has varied widely in popularity. At one time it was almost displaced by amalgams which were cheaper and easier to make. After a time it regained its popularity only to face severe competition with a corresponding loss of ductility. The cast gold inlays which were developed at the beginning of the 20th century. The conspicuous color of the gold inlay is highly objectionable and as a consequence they face a fierce competition from the ceramic cements and porcelains as well as from the light colored cast gold alloys which approach the natural tooth in appearance.

Amalgam alloys were introduced at the beginning of the 19th century, but because of the dishonesty prevalent they fell into disrepute. They have now regained their popularity. The silver alloys consist of intermetallic compounds of silver and tin and have a compressive strength exceeding 40.000 lbs. sq. in.

The use of gold castings was accelerated when it was found that a wax impression of the cavity could be made. At first, gold coins were used for castings but alloys of gold, copper, and silver, followed by complex alloys of platinum, palladium, nickel and zinc replaced the gold coins. Several difficult foundry problems arose; the most important of which was accurate dimension of shrinkage of the metal when passing from the liquid to the solid state. Research by the National Bureau of Standards helped solve this problem.

Many of the gold alloys respond to heat treatment as they form intermetallic compounds. The formation of these compounds increases the hardness and strength of the alloys with highest physical properties are found

in wrought golds. These contain a high platinum content and possess a tensile strength close to 200,000 lbs./sq. in., and a Vickers hardness up to 350.

Three types of solders are supplied to the trade for 22, 20, and 18 carat work. These solders also respond to heat treatment and require fused borax as a flux. The silver solders contain silver, copper, and zinc, or, silver, copper, zinc, and tin. Platinum is used in the pure form as well as an alloying agent for the high strength alloys. In the form of a foil it is used as a matrix for porcelain inlays, porcelain-jacketed crowns, and plates for dentures. It is also used as a heating element in porcelain furnaces.

Palladium is used as a substitute for platinum. It is used to whiten castings and to increase their strength. It costs three-fourths as much as gold at the present time and has a volume 50% greater than an equal weight of platinum. The alloys of palladium respond to heat treatment. Nickel is used as a substitute for both platinum and palladium. It increases the hardness and strength of the casting. The main objection to its use is that it tarnishes. Stainless steel of the 18-8 type has excellent corrosion resistance properties. It can be soldered when gold plated. The chief use for this alloy is for clamps, crowns, orthodontial wire, instruments, and full or part dentures. Other alloys employed by the dental profession are fusible alloys of bismuth, antimony, tin, and lead; nickel silver containing nickel, copper, and zinc; and heat resisting alloys of nickel and chromium or nickel, chromium, and iron.

New Pyrometers for Very Hot Gases

By E. O. Mattocks

(From Metal Progress, Nov., 1934)

THE range of thermoelectric pyrometers is limited by the affects of the atmosphere at high temperatures. The maximum temperature is 2800° F., and this is obtained only with a platinum couple. Beyond this range three devices are available for temperature measurements: (a) optical pyrometers, (b) radiation pyrometers, (c) spectral-line reversal pyrometers. None of these instruments require direct contact with the medium which is to be measured, but obtain their motivating energy from radiation, which is the visible spectrum. The one exception to this is the total radiation pyrometer, which converts all of the electromagnetic waves. Hot gases give off very little visible light, and to make them more luminescent a volatile salt such as table salt is introduced into the hot gas.

The most frequently used device to measure high temperatures is the optical pyrometer. It has a useful range of 1400 to 5000° F. The most common type is the disappearing filament type, in which the brightness of the tungsten filament is regulated until its image disappears against the back-

ground of light from the object whose temperature is measured. Filters are employed so that most of the short waves are cut out, leaving a predominance of red rays.

In the radiation pyrometer the radiant energy is converted to electrical energy by focusing the radiations on a sensitive thermocouple. This electrical current can be continuously recorded on an automatic recorder which in turn can automatically regulate the quantity of heat in a process. These instruments indicate the black body temperature. The range is the same as for the optical pyrometer.

Optical and radiation pyrometers give the temperature of the solid viewed and not the temperature of the gas surrounding it. To ascertain the gas temperature the spectral-line reversal method may be used. This is a new method for gases although it has been used for flame studies.

To obtain a temperature measurement by this method, the radiation of a certain wave-length emitted from a gas stream whose temperature is desired is compared with the radiation of the same wave-length in a band spectrum from a carbon arc or electric lamp. In order to obtain a definite wave-length from the hot gas stream, finely ground sodium chloride is used to get the familiar lines, D_1 and D_2. The lines as seen through the spectroscope, are superimposed on the band spectrum.

If the lamp filament is colder than the gas, the line spectrum of the sodium is brighter than the background; if the filament is hotter than the gas, the lines appear darker than the adjoining spectrum. By adjusting the current in the lamp, a point can be reached where the lines and the band spectrum become indistinguishable. At this point the temperature of the filament is the same as that of the gas. The range of this apparatus is 2300 to 5000 F. Any atmosphere or flame can be measured irrespective of the luminousity. When the necessary corrections are applied, an accuracy of ± 10 F. can be attained.

Can Trade Secrets Be Legally Protected?

By H. A. Roderick

(From Machinery, Dec., 1934)

A TRADE secret has been legally defined as "a plan or process, tool, mechanism, or compound known only to its owner and those of his employees to whom it is necessary to confide it in order to apply it to the use intended."

It differs from a patent in that when an article manufactured by some such process which is not patented is placed upon the market, anyone, may discover, if he can, either by an examination of the product or by other honest means, what the process is. The discoverer may sell the process or use it to manufacture similar articles. If the knowledge is obtained by a breach of contract or confidence, the rule is otherwise.

A trade secret is, therefore, a prop-

erty right which may be assigned, and which the courts will protect by injunction against unwarranted disclosure and unauthorized use by others than the rightful owner. The owner is entitled to protection from a breach of confidence or contract against one to whom he has confided the secret and those to whom the confidant may divulge it. He is not entitled to the aid of the court in preserving his secret from becoming known to the general public.

In a suit to prevent unlawful use of a trade secret, the claim that the plan, process, tool, mechanism, or compound is a secret must be clearly established, since what is commonly known to the trade is not a trade secret; an injunction will not be granted against unauthorized use of a trade secret unless it appears that the plaintiff developed or invented the secret or that he is possessed of the sole right to its use.

The right to protect a trade secret is not confined to secret processes of manufacture. The principle has been extended by the courts to include the names of customers whose trade has been secured by effort and the expenditure of time and money. These names constitute a part of the good will of a business, which enterprise and foresight have built up and are considered just as much entitled to protection as a secret formula for compounding some material.

The customers of a particular business cannot be strictly a property right since a knowledge of them can be easily secured by legitimate effort. The following rules in accordance with legal decisions answer questions regarding the circumstances under which employers can restrain a former employee from soliciting his customers for a business rival.

1. If an employe surreptitiously copies the names and addresses of his employer's customers or carries away any document containing trade secrets or other confidential matter relating to his employer's business, he will be enjoined from using these records in securing the patronage of such customers for himself or another employe; and anyone who obtains the records from the employe will also be prohibited from using them.

2. If an employe solicits his old customers, leading them to believe that he is still working for his former employer, he will be enjoined.

3. In the absence of an express contract not to do so for a reasonable period of time after he ceases his employment, an employe will not be enjoined from soliciting business from his former employer, providing no trust or business secret is violated, and anyone employing him will not be enjoyed from using his knowledge.

Termite Control for Utility Structures

By A. A. Brown

(From Electrical World, Nov., 1934)

MORE than fifty species of termites are native to the United States and are found in destructive

and increasing numbers in practically every state. Termites, useful forest scavengers, have become economic problems as a result of artificial accumulation of their natural food supply, timber, which they break down into soil and air.

As civilization advances, man avails himself to the use of wood more and more. At the same time he distributes these insects, so that now the forest is no longer the principal reservoir of infestation. Wood used for construction purposes encourages the breeding of these parasites as the tree which has been cut down has more desirable food elements than the rotting forest stump. To date, little progress has been made in establishing control measures as very little is understood about their habits and activities.

Termites are commonly but erroneously known as "white ants." Not all species are white, and no termite is a true ant. It is true, however, that the vast majority are white. The "alates," a dark body termite with white wings swarm after the first autumn rains. The dry wood termites usually begin to swarm in July and continue to the middle of October. The majority of the wood dwelling types attack dry wood only. They are confined to the coastal and southern states. The damp wood types are largely confined to the Pacific Coast. Of the earth dwelling termites, the subterranean types are the most important as they attack wood placed on or in the ground. Wood destroying fungi and termites are very commonly found in close association.

Arsenic compounds provide an economical and easy method of preserving wood. Its use should be discouraged because of its toxic properties; many fungi convert the powders into volatile compounds which will also cause poisoning. Crude creosote has long been a standard preservative against decay and insect ravages. Recently, a transparent creosote oil has been made which has remarkable penetrating properties, will not change the color of the wood, is not dry or oily, non-irritant, has higher electrical resistance than black creosote, will mix with paints, and can be applied by an ordinary workman, thus eliminating treating tanks.

Many cities now have ordinances requiring all lumber used for underpinning to be treated with a suitable preservative to check the subterranean termites. The way is still open to the termites as they can make covered passageways over the treated lumber to the untreated wood.

ENGINEERING PROGRESS

NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

Hose Joint

A NEW hose joint which eliminates all contact between metal and fluid has just been patented. It is said to permit greater flexibility than any other type of coupling or joint and to afford a perfect seal in all suction and discharge service up to one hundred twenty-five pounds working pressure. The end is built into the hose and consists of an enlargement or bead reinforcement with plies of fabric surrounding a rigid steel ring of angular cross section. The joint is assembled with the aid of split flanges and standard bolts. Two successive lengths of hose can be bolted together with rubber ends of the hose compressed to form a seal. When the bolts are drawn up the pressure of the split flange against the flared hose end provides a positive and unyielding clamping of the joint. This joint can very well be used as a substitute for nipples and flanges.

Electric Meter Body

A METER body for electric flow meters has been designed for measuring the flow of any liquid, vapor, or gas creating a differential pressure across an orifice of 1.6 to 16 inches of mercury.

Some of the outstanding features are ease of cleaning and range changing, ruggedness, and simplicity. A seamless "U" tube with union compression fittings connects high and low pressure chambers. The mercury drain mounted on the tube has a hardened needle point screw which seals the mercury drain hole in the "U" tube. The mercury cannot be blown out of this meter body under severe overload or reverse flow conditions. Two highly resiliant seals of an oil resisting material set firmly in the high pressure chamber, as a seal on top, and one underneath. As the mercury level rises and falls, the float in the high pressure chamber is free to move and it accurately follows the mercury level. Movement of the float is transmitted electrically to the indicating or recording meter. Since it has no pressure bearings to leak, no gears, links or chains to wear or break, and no electric contacts to foul in mercury, this body should be very desirable for industrial purposes.

V-8 Refrigeration Compressor

A RADICALLY new type of refrigeration compressor built in the form of a V has recently been de-

veloped. The eight cylinder compressor has no piston pins, piston rings, crankshaft, gears, cams, connecting rods, or valves.

The compression cylinders are forced in a cylindrical block of metal, four of the cylinders being forced into each block. The pistons are forged in pairs and are placed in the compression cylinders in the block, which in turn are placed in the outer cylinders.

One of the unusual features of the compressor is its method of operation. Power is applied to the shaft, which is directly connected to the compression cylinder block which revolves in the stationary cylinder. As the block revolves it carries the pistons around with it, and at the same time the downward moving pistons are forced to move out of the cylinder, leaving a space for the refrigerant. The upward moving pistons are forced back into the cylinder, compressing the gas.

The compression cylinders and pistons rotate immersed in oil. Valves are not used, discharge ports in plates at each end of the cylinder being treated in such a manner that as the blocks rotate, they pass across the intake and the outlet ports at the proper time in each cycle. This allows the piston to work within small clearance of the cylinder heads, giving a high volumetric efficiency.

The complete lack of vibration should make this compressor a success in its field.

Processed Oils

A NEW series of industrial lubricants which have unusually high film strength due to a special polymerization treatment has lately been perfected.

These new products are made of pure mineral oil which is polymerized under carefully controlled heat and pressure. This treatment results in a complete re-arrangement of the molecules of oil without any change in chemical content, thus producing a much closer bond between all of the molecules and consequent increase in film strength.

Actual tests on scientific testing machines indicate that this treatment increases the film strength of the oil by 40 to 65%. In addition, the oils cling to the bearing surfaces and do not drop or spatter as easily as ordinary mineral oils, thus giving the maximum lubrication and minimum wear and tear on the lubricated surface.

Water Strainer

THE strainer embodies a backwashing principle by means of which the strainer is cleaned while in operation. This strainer is comprised of two baskets placed at 90 degree angles to each other, through which the water flow is controlled by two swinging gate valves. The strainer basket is a cylinder, perforated to give the desired screen opening, the top and bottom of the basket being open.

Water enters at the bottom and divides, half passing through each strainer basket. To clean one of the baskets the bottom gate valve is closed, cutting off the inlet water to that basket. The by-pass valve on that basket is then opened with the result that clean water from the discharge of the other strainer basket is forced through the first mentioned strainer basket in the reverse direction, flushing the dirt out of the basket and through the by-pass valve. The by-pass valve is then closed and the gate opened.

To remove the strainer basket for inspection both of the gate valves are closed whereupon the basket is removed the same way as the conventional type of twin basket strainer.

The swinging gate valves consist of a bronze disc, which is held against the bronze seat by the line pressure of the water. The disc is carried on a stainless steel shaft which is held in live rubber bushings with the result that the shaft is free to shift its center to allow the swinging gate to seat perfectly.

The strainer baskets are made of brass with rings at the top and bottom. The straining area is considerably greater than the area of the inlet. The strainer can be mounted in any position.

This type of strainer is adept for cleaning the water used for general service requirements about a plant.

Radioactivity Research Spurred by New Principle

A NEW principle of separation of man-made artificial radioactive elements from the normal substances from which they are produced has been announced. The discovery is expected to speed research in the field of atomic studies of how the smallest unities of matter are composed.

The new method, which is called "a new principle of separation," is used for concentrating an artificially produced radio-active element even in the case where the radioactive element is an isotope of the original element.

Thus, for example, by bombarding the iodine crystals with neutrons it is possible to produce a radio active form of iodine, but hitherto it has been impossible to separate the isotopes. The discoverers report that they have found a way to separate the two forms of iodine.

The method is based on the following reasoning:

1. It is logical to expect that the atoms of an element struck by neutrons in atomic collisions should be removed from the compound. 2. Around the target, would be a swarm of struck elements. But normally there would be a constant interchange between these free radioactive atoms and the normal non-isotopic atoms still in the target. 3. But if the impact experiments are carried out under conditions in which this interchange is impossible

or considerably reduced it should be possible to obtain the "free" radioactive element. Chemical changes like reduction and precipitation might then be able to remove the radioactive atoms permanently from the scene.

The method should be especially valuable for the many radioactive elements having atomic numbers higher than 30. Below the atomic number 30, artificial radioactivity produced by neutron impact commonly creates substances having different chemical properties. Thus a radioactive gas may be created from a solid element, just as radon gas is produced by naturally disintegrating radium.

Above the atomic number 30, however—as in the case of arsenic, bromine, iodine, gold and iridium—radioactivity can be produced, but most of it stays in the target. Its presence can be detected but it is most difficult to concentrate it. The new method appears to have solved one problem. For iodine, a concentration of the radioactivity ten times more than normal has been achieved.

Photography Made Possible on Aluminum Surfaces

A NEW process, which makes possible durable photographs on metallic aluminum plates and its alloys, has recently been developed. It has been known that aluminum and its alloys would procure oxide films which readily absorb solutions of pigments and thus attain brilliant color effects.

The new method takes advantage of the porosity of such oxide films by having them absorb light-sensitive substances instead of pigments. The aluminum sheets are dipped successively in solutions of aluminum chloride and silver nitrate and dried after each immersion. Other silver salts, iron salts and diazo bodies can be used to make the metal plate light sensitive.

Finished photographs made on metallic films are characterized by great durability because the film of oxide protects the underlying aluminum from chemical and mechanical influences. Such photographs will resist the effects of light, water, and weather.

Even if the aluminum is placed in a fire so hot that it is melted the picture on the oxide part of the plate will still be clearly visible. The metallic photographs are very much better than the ordinary picture in that they are resistant to organic solvents such as alcohol, ether, acetone, and benzine.

This process can and perhaps will become very important in the commercial world thru its uses.

Glass Stops Heat, Passes All Light Rays

GLASS experts have produced a glass which absorbs most of the heat rays in sunlight, yet passes almost all the visible part of the sun's spectrum. The new glass will be useful in skylights and windows in industrial plants of the south during the hottest

months of the year. In addition, it will be useful in air conditioning, since it has a low heat of transmission coefficient.

Solar energy, as it seeps through the atmosphere of the earth, has only about one-third of its rays in the visible region of the spectrum. The rest of the sun light consists of the invisible ultra-violet light one on side and the unseen, infra red, or heat on the other side.

The heat absorbing glass cuts down the heat ray portion of the spectrum. Small amounts of iron in the glass act as heat catchers. Some types of glass will stop and absorb about 52% of the heat rays. Another 8% is reflected off the surface of the glass. The remainder consists of the visible rays.

While the heat that is absorbed by the glass must be re-radiated, much of it is carried away by the proper design of ventilation around the window or skylight. What remains after this process is radiated half to the inside and half to the outside. The part coming into the room is spread out in all directions. A person sitting in a beam of sunlight in the room feels little if any heat from the beam.

Acid—Proof, Heat—Resisting Stoneware

HEAT-RESISTING and acid-proof stoneware can now be made into rectangular plating tanks and cylindrical acid pots which are wanted to withstand high heat and sudden changes in temperature, by a new process. It is claimed that there is no other heat-resisting and acid proof stoneware on the market which even approaches the new ceramic in its resistance to high temperature, unusual thermal shocks, and in corrosion proof properties.

The ceramic occupies a position about halfway between chemical stoneware and fused silica ware. Its ultimate tensil strength is approximately eight thousand pounds per square inch. Its ultimate compressive strength is about one hundred and eighteen thousand pounds per square inch. It also has a good thermal conductivity of between seven and a half and fifteen B.T.U.

The stoneware is so extremely hard that grinding and finishing operations are done with difficulty. No glaze can be applied to this material. The material can be made into any article of any size or shape.

At the breakfast table, he was relating to his wife an incident that occurred at the lodge the previous night. The prexy of the order offered a silk hat to the brother who could truthfully say that during his married life he had kissed no woman but his own wife. "And would you believe it, Mary, not one stood up."

"George," his wife said, "why didn't you stand up?"

"Well," he replied, "I was going to, but you know, dear, I do look funny in a silk hat."

* * *

"Your doctor is here with a flat tire."

"Diagnose the case as flatulency of the perimeter, and charge him accordingly," said the garageman. "That's the way he does."

* * *

Proud mother: Yes, he's a year old now, and he's been walking since he was eight months old.

Bored visitor: Really, he must be awfully tired.

* * *

Judge: Are you positive that the defendant was drunk?

Officer: No doubt.

J: Why are you so certain?

O: Well, I saw him put a penny in the patrol box on Fourth street, then look up at the clock on the Presbyterian Church and shout, 'My God, lost fourteen pounds.'

* * *

From an Ad in Paper

Lady's purse left in my car while parked. Owner can have same by paying for this ad.

N. B. If she will explain to my wife, how the purse got there, I will pay for the ad myself.

* * *

Dean (to mother of freshman): Your son has a great thirst for knowledge. Where does he get it?

Mother: He gets the knowledge from me and the thirst from his father.

* * *

Father to son: Why don't you get out and find a job? When I was your age I was working for three dollars a week and in five years, I owned the store.

Son: You can't do that nowadays. They have cash registers.

* * *

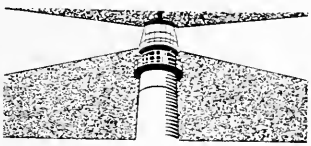
To the Oil Administrator:

I get my oil from Perry. He send me to Oil Administrator. He refer me to Vegetable Fat Section. Fat Section refer me to Lubricating Oil Section. Lubricating Oil Section refer me to you. Christ Almight, who you refer me to?

G-E *Campus News*

SEDAN TO SYDNEY

Radio Engineers were up bright and early not long ago to make a two-way radio-conversation test between the General Electric short-wave station W2XAF near Schenectady and station VK2ME at Sydney, Australia, 10,000 miles away. It was 6:30 a.m. in Schenectady and 10 o'clock at night in Sydney. Everything was in readiness, but C. H. Lang, U. of Michigan, '16, manager of the Company's Publicity Dept., who was to talk to officials in Australia, was delayed at his home. On a chance, the radio police test car, which G-E engineers had equipped for two-way radio communication for the Boston Police Dept., was sent to pick up Mr. Lang. From the car, Mr. Lang's voice was sent by ultrashort waves to the G-E plant and from there by land wire to W2XAF for transmission to Australia. Conversation from Australia was picked up at the short-wave station, sent by land wire to the plant, and from there by the special police transmitter to the moving car. So successful were the results, despite the complicated hook-up, that the small sedan continued to cruise about the Schenectady streets for 15 or 20 minutes more. Mr. Lang carrying on his part in the conversation through an ordinary French-type telephone.



YELLOW LIGHT ON CAPE MAY

The orange-yellow light of General Electric sodium-vapor lamps now illumines roadways in more than 50 installations. It is also being used to light the façades and towers of buildings.

But now this light has another application—in the lighthouse at Cape May, N. J., at the entrance to Delaware Bay. The Cape May Lighthouse was erected in 1859. Its light source is 165 feet above mean high water and can be seen for approximately 19 nautical miles under clear atmospheric conditions.

In this test with the sodium-vapor lamp, all equipment has been supplied by the General Electric Company, and the installation was made by the Fourth Lighthouse District.

FISH GYM

The patrons of Joe Medway, a restaurateur up in New York State, literally fished for their dinners. They chose and netted their trout from a large pool. But what made Mr. Medway and his patrons unhappy was that the trout, presumably because of the treacherous refinements of effete pool life, became sissies. They just nosed around listlessly.

One day Mr. Medway gathered up a batch of netting by the pool and placed it in his General Electric washing machine for a rinsing. When he removed the net, there was a trout jumping about the machine in a most sprightly fashion. It exhibited such joyous abandon, in comparison with its sluggish brothers in the pond, that he turned on the activating element again to give it real satisfaction. The trout then accelerated its speed and leaped about in the swirling currents as though it were swimming for life or love in a mountain stream. Mr. Medway threw it back in the pond. It was off like a flash, and had soon churned up the placid waters into a sea of tiny whitecaps with its capers. Then, says Mr. Medway, the bit of spotted dynamite swished in to shore, came to a spray-rising stop, and with wiggles and flops implored its owner for another turn in the washer.

Well, Mr. Medway bought six more General Electric washing machines, and now all the trout are systematically exercised. Mr. Medway is willing to bet that there isn't a single speckled trout from the wildest streams in the country that could last a half a round with his trout. "Because," he says, "they're scientific trained."

96-91-FBI

GENERAL ELECTRIC

SEVEN HUNDRED WELDS—were needed to make this assembly of aluminum piping.

New Metals Emphasize Desirability of Jointless Design

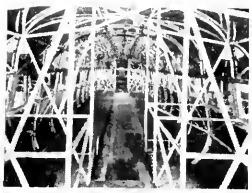
Welding Preferred Method for Fabricating Jointless Designs from New Materials

By H. E. ROCKEFELLER*

Welding is an important aid in securing the full benefit of the newer light weight alloys, corrosion- and stain-resistant steels and other ferrous and non-ferrous metals. Jointless welded designs in these new metals make the finished product attractive in appearance, efficient and economical to use and enable it to be priced salably.

In All Industries

Fabrication by welding can be undertaken without heavy capital expenditures and carried out at low cost. Welding is used in every industry for maintenance, for construction and for the fabrication of many products. The welding of mechanical refrigerators and gas ranges is typical of its production applications. Other typical applications include welding of chromium steel for resistance to sea water corrosion on seaplane pontoons, welding aluminum fuel tanks for airplanes, welding of the frame work of alloy steel on the new high speed railroad trains, welding of stainless steel beer barrels and innumerable other familiar products.



HERE'S HOW—the framework of the light weight, streamlined rail cars for high speed is Linde-welded from chrome-molybdenum steel tubing.

Welding is Simple Production Tool

Welding is the preferred method of fabricating almost every design in modern metals. Jointless welding can be done rapidly with a minimum of preparation of the pieces to be joined. Under procedure control providing jigs for positioning pieces, production can be as rapid and as free from rejections as any highly developed factory process. From the plant equipment standpoint it is easy to adopt welding. From the personnel standpoint the welding technique is quickly acquired through instruction by competent engineers.

For Jointless Strength and Safety

Products fabricated by welding are jointless, leakproof, permanent and safe. Improved methods of testing make it possible to tell exactly what stresses or loads a jointless welded assembly can take. Metals of different compositions, providing the most suitable material for the service it is to perform, can be welded into sound unified assemblies forever free from any of the losses which occur from joint failures.

Specialized Welding Assistance

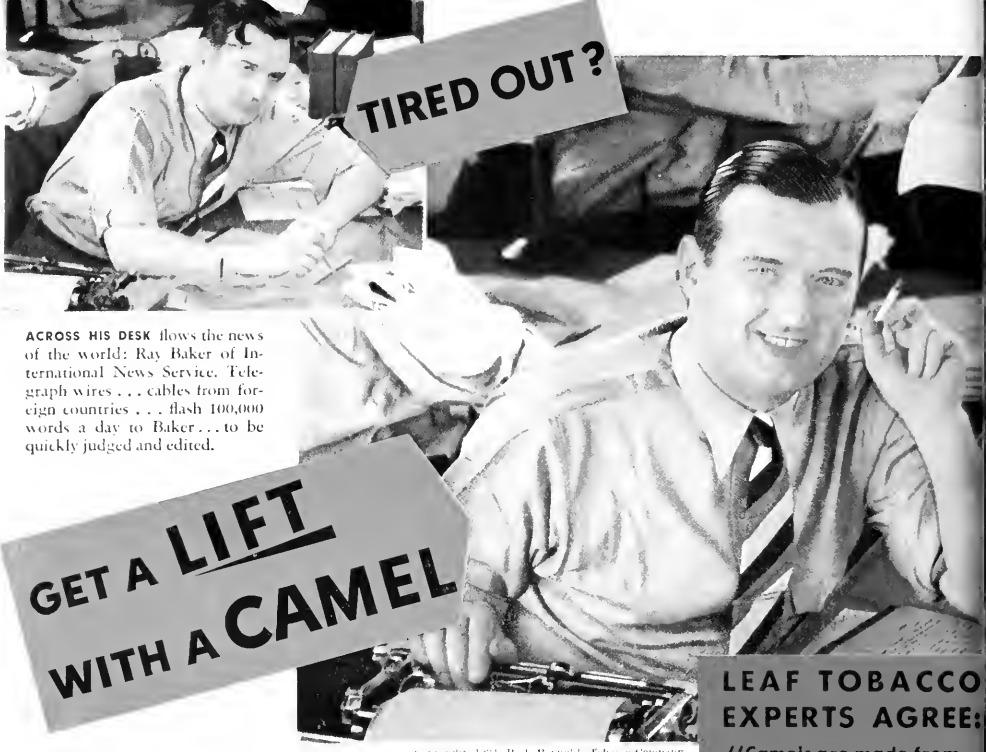
To utilize the new alloys and metals fully, the advice of competent engineers in welded design is advisable. The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation, has for many years specialized in the development of new ways to use oxy-acetylene welding. Linde Engineers will gladly consult with you without obligation, and help you use welding and

IN JIG TIME—using jigs, welded joints can be made quickly in any commercial metal or alloy.

organize for welding production. This assistance can be secured by a telephone call to any Linde Sales Office. They are located at Atlanta — Baltimore, Birmingham, Boston, Buffalo, Butte—Chicago, Cleveland — Dallas, Denver, Detroit—El Paso—Houston—Indianapolis—Kansas City—Los Angeles—Memphis, Milwaukee, Minneapolis—New Orleans, New York—Philadelphia, Phoenix, Pittsburgh, Portland, Ore.—St. Louis, Salt Lake City, San Francisco, Seattle, Spokane and Tulsa.

Everything for oxy-acetylene welding and cutting—including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through producing plants and warehouse stocks in all industrial centers.

*Engineer, Development Section, The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.



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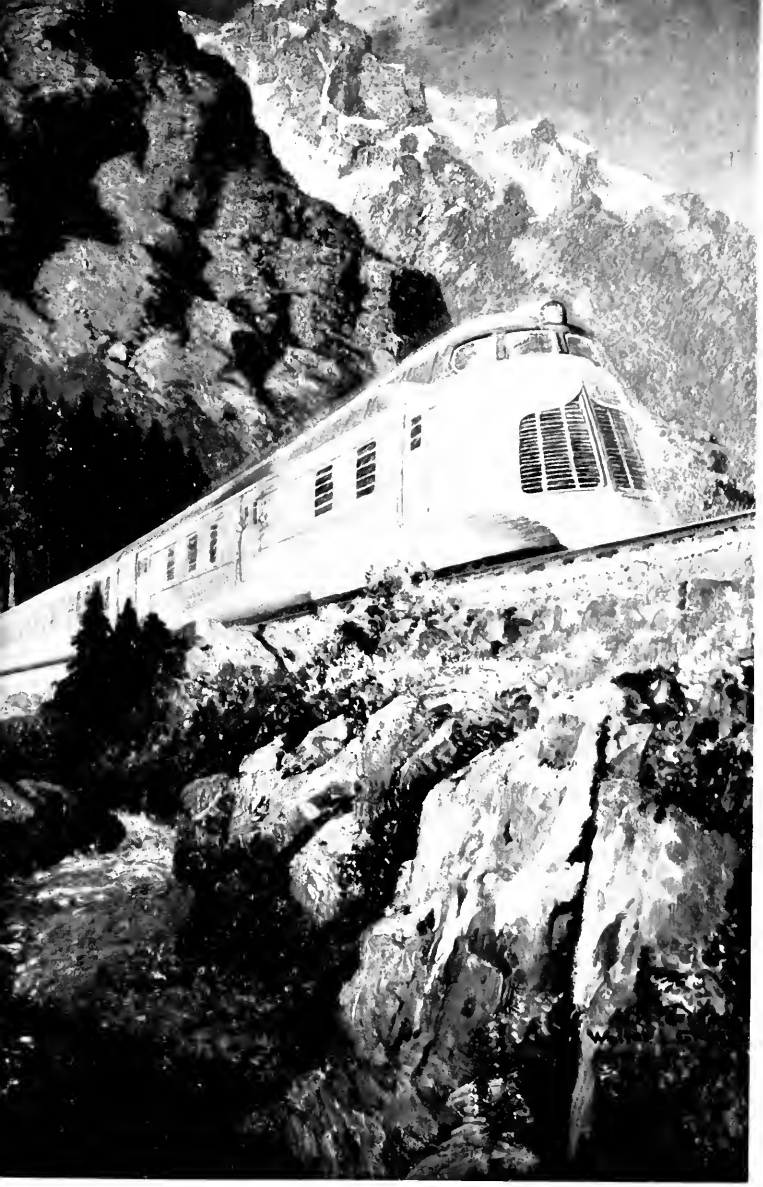

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MARCH, 1935

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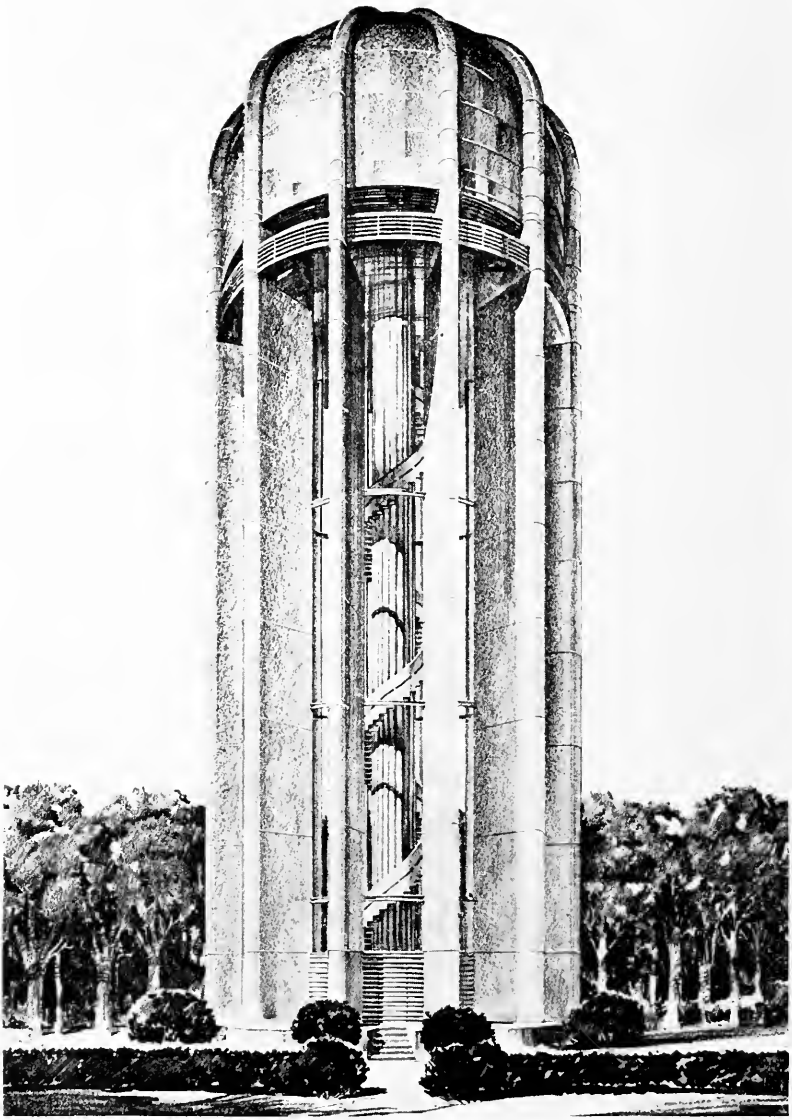


A MODERN WATER TOWER

THE
ARMOUR ENGINEER

MARCH, 1935

Developments in Engineering Education at Armour

By DEAN H. T. HEALD

FOR forty-two years Armour Institute of Technology has been rendering an important service in preparing young men for the engineering and architectural professions. Founded in 1892 by Philip D. Armour, to provide opportunity for all who earnestly seek technical education, it has continued to fill a great need in the Chicago area and to exert a profound influence on the cultural and industrial life of the midwest. More than ten thousand young men have enrolled for the four-year courses in engineering and architecture. The important positions reached by Armour Alumni and former students today is evidence that their studies have properly fitted them for a place in the community.

No mention of the growth and development of Armour Institute of Technology would be complete without including the names of some of the men who played an important part in shaping its policies and aims. Good teaching and emphasis on individual student development have always been inherent characteristics of Ar-

Editor's Note: This is the first of a series of articles by Deans of Middle-Western Engineering Colleges.

mour. No institution has had a faculty more loyally devoted to the task of educating young men. Former students and alumni of the school will remember Dr. Gunsaulus, Dean Monin, Dr. Raymond, Dean Palmer, Professor Gebhardt and Professor Leigh, only to mention a few, while many other members of the faculty served equally long and faithfully. The Armour alumnus, thinking back over his college days, well remembers the characters and personalities of his teachers, and the intimate associations with them, made possible in a school of relatively small size.

The Institute began instruction with four-year courses in mechanical and electrical engineering. The School of Architecture, conducted at The Art Institute of Chicago, soon became affiliated, and courses in civil engineering and chemical engineering were shortly added. One of the pioneer institutions in the field of chemical engineering, facilities available for prospective students in this department have been inadequate to meet the demand even during the period of recent economic depression. The course in fire protection engineering was added in 1903 to meet the demand for trained engineers in the fire insurance field, and it has been continuously developed with the cooperation of the Western Actuarial Bureau. Graduates of this department now occupy many important positions in insurance work. The successful continuance of this course for over thirty years is an excellent example of cooperation between an educational institution and the industry which it serves. Armour is today the only college in America offering a course in fire protection engineering.

Many changes and improvements have been made in the courses of study since their original establishment. The scope of scientific and technical knowledge has widened immeasurably, and curricula and methods of instruction have been developed to keep pace.

In 1923 the Society for the Promotion of Engineering Education began the most comprehensive study of technical education ever attempted. This included a thorough survey of all colleges of engineering and technical institutes in America, as well as comparisons with European practice. This

survey, representing a critical appraisal of the whole machinery for engineering education, by engineering educators, has proved of immense value to the colleges of engineering and to engineering teachers. The results have been published in two bound volumes, as well as in many papers in the Journal of the Society. When the first volume of this report was published some changes were made at Armour to make the curricula more nearly in conformance to the Society's recommendations.

In 1932 a thorough study of Armour's place in the field of engineering education was undertaken by members of the faculty and trustees of the Institute. This study was summarized in the Armour Plan. Many features of this plan have been put into operation and others have been modified in the light of changing conditions. As a direct result of the Armour Plan, the course in Engineering Science was established, and fifth-year courses leading to the degree of Master of Science in engineering and architecture were initiated.

The Armour Plan pointed out the desirability of introducing into the curricula additional work in the cultural subjects, while reducing to some extent the amount of time spent in courses of a highly specialized nature. In the fall of 1933 changes of this sort were actually made. Early in that year, Dr. Willard E. Hotchkiss became President of the Institute, and after a thorough investigation of the curricula and the internal organization, the following changes effecting courses of study were made.

(a) The freshman year was made uniform for all engineering departments.

(b) Required courses in the social sciences were introduced in the freshman year and the senior year.

(c) Courses in English were strengthened, with some increase in total time.

(d) Shop courses were temporarily suspended, pending an investigation by a committee of the engineering faculty.

These various items will now be discussed in detail.

The Freshman Year

The Society for the Promotion of Engineering Education, in the report mentioned above, recommends that the first-year courses be made uniform for all departments of engineering. The advantages of this arrangement are obvious. No fundamental differences exist between the basic studies in the various engineering departments that can justify differentiated curricula during the freshman year. Many students are not sufficiently familiar with the various branches of the profession to make sound decisions as to the field they wish to specialize in. A uniform first year allows time for orientation before such a decision is necessary. Inasmuch as many students entering engineering college have decided to do so with a somewhat

inadequate knowledge of what engineering itself is, it is not surprising that their first choice of a field of specialization should be faulty.

Although this system has been in operation only one year, numerous instances of a change in the original choice of the engineering option show the advantages of the arrangement.

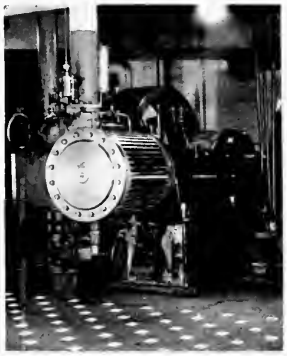
Social Sciences

A conventional one-year course in economics has for many years been a part of the curriculum in all courses at Armour. It is believed that the new courses in business and engineering problems and social and engineering problems in the freshman year, followed by courses in public policy and business policy in the senior year, will provide the student with a much better understanding of social institutions and social forces, as well as a greater ability to deal with economic problems arising in the realm of engineering. These courses are maintained on the same high plane as work in mathematics and science, and the engineering approach to social economic problems is especially emphasized.

This is something of a departure from the conventional methods of teaching economics to engineers, but the results of the first year's trial are encouraging. Numerous developments and changes in method of presentation will undoubtedly come about as the work progresses.

English

Prior to 1933 the English requirements in all courses at Armour totaled



six semester hours. This requirement has been increased to eight hours and some purely lecture courses in general literature have been eliminated. Sub-freshman courses in English have been introduced for those students found to be lacking in the fundamentals of composition and rhetoric. The offering of elective courses in drama, public speaking, and literature has been considerably broadened, and many students have elected this work. Members of the engineering faculty have been active in promoting among the student body a greater sense of the importance of good English.

Shop Courses

The faculty committee on shop policy, appointed in the spring of 1933, has been engaged in a thorough study of the work that should logically be included in shop courses at Armour. Questionnaires were sent to all other engineering schools, to a selected group of graduates of the Institute, and to a group of personnel directors

in industry. All other surveys and available literature on the subject were studied. As a result of this survey, the committee has made definite recommendations for the re-establishment of shop courses at Armour. In the opinion of the committee, the following purposes should be served by shop courses in the engineering curricula:

(a) Development of knowledge of shop machines and processes.

(b) Development of knowledge of the properties of materials employed in shop practice.

(c) Development of knowledge of fundamentals of shop economics and management.

The new shop courses will differ materially in content and method of approach from those of the conventional type formerly offered at the Institute and at other colleges of engineering. A large number of Armour students come from the technical high schools of Chicago and other cities where excellent training in the manual aspects of shop work are provided. Consequently, the emphasis in the new courses will be on the materials and machinery of production. Work in machine shop and properties of metals will occupy a prominent place, with a corresponding reduction in forge and founding, and with the probable elimination of pattern shop. Present plans contemplate the initiation of these courses in 1935 and 1936.

The problem of finding a job has been the cause of more concern to college graduates in recent classes than at any time for many years. Prior to the period of the depression, Armour graduates, in common with those of other engineering schools, were very much in demand. The young engineer was faced with the problem of deciding the kind of work he wished to accept, or of selecting the most attractive offer. It is well known that this has not been the case for the past several years, and the engineering schools today are faced with a definite problem in marketing their graduates. This condition is resulting in much greater emphasis being placed on a function that should at all times be a definite part of the service rendered by an institution to its graduates and to the community; nor will it suffice to concentrate only upon finding the first position for the young graduate. A properly organized personnel and placement department can perform an excellent service in following up the graduates of the school and in bringing new opportunities to their attention.

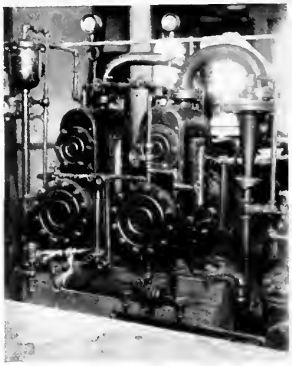
In 1932, a full-time Placement Officer was added to the staff of the Institute, and definite steps were taken to develop this service for the graduates. Although somewhat hampered by inadequate records and by the fact that the older alumni did not look to the college for assistance, several hundred men have been placed in various kinds of positions. The great value of this service to alumni during a period of deepest depression is evi-

dent. Even those graduates who did not secure positions must have been greatly cheered to know that these facilities for help were operative.

This personnel and placement work is now being materially strengthened. A committee of the faculty is actively at work developing plans for cooperating with the Placement Office, both in making professional contacts for graduates and securing adequate personnel records of graduates and students. With this work properly consummated, Armour Institute of Technology will be in a position to render a signal service to its graduates and to industry.

It is interesting to consider other future developments and changes which may be expected at Armour Institute of Technology, in order that the institution may render greater public service. The courses of study in an engineering college such as Armour will continue to change progressively with advancement in scientific knowledge and new industrial developments. The current tendency for moderate diversity, but tending away from excessive specialization, seems destined to be continued. A well integrated sequence of required subject matter should be included, but more opportunity for the student to select elective subjects seems desirable, particularly in the third and fourth years. Management and industrial engineering are fields which might well come in for more emphasis in an institution located in the heart of an industrial area. This work may logically be included as optional or elective subjects in the major engineering courses now offered at the Institute without the necessity of creating additional major divisions of specialization.

Graduate courses and research may well be extended as the facilities and demands increase, but Armour's great-



est contribution will continue to be the soundness of its four-year undergraduate curricula and the excellent quality of its teaching.

Other new opportunities exist in the field of adult education, although evening courses have been provided at the Institute since 1907, and many thousands of men employed during the day have received technical training in engineering and architecture in these classes. Adult education courses to be offered in engineering and architecture in the future might well be classified as follows:

(a) A four-year evening program equivalent to the first two

years of the college of engineering or architecture. This would provide an opportunity for a high school graduate not immediately able to attend college to continue his education and complete the first two years' work before entering the day college.

(b) A well integrated program of courses on the technical institute level for those students not interested in college credit or degrees but who wish to secure adequate specialized training in a particular branch of engineering or in architecture. A very large percentage of the evening school students in the past have been of this type.

(c) Courses on the post-graduate level. These courses would appeal to college graduates, employed in Chicago and vicinity, who desire further specialized training in the professions and yet are unable to finance full-time attendance at a graduate school. Very little work of this type is now available in Chicago although thousands of graduate engineers are employed in the vicinity. By providing these courses, the Institute could be of great service in encouraging the professional training after graduation, which is becoming increasingly important to engineers today. Courses of this kind might possibly be developed in cooperation with the local engineering societies.

In conclusion, the services rendered by Armour, as Chicago's college of engineering and architecture, may be summarized as follows:

1. To provide a thorough education through the four-year undergraduate courses and a fifth-year graduate course for the professions of engineering and architecture.
2. To furnish adequate opportunities for adult education in the technical field by means of evening classes or part-time classes.
3. To supply facilities and personnel for specialized industrial research as an aid to industry and as a means of training students for original investigation.

All of these responsibilities are accepted at Armour Institute of Technology. Many new improvements and new developments will be made from time to time, but the fundamental structure is sound. Quoting from the report of the Board of Investigation and Coordination of the Society of Promotion of Engineering Education, "For better engineering education, we must look to better balanced curricula, better selection of students, better teachers, better methods, better subject matter, and better advanced training rather than changes in educational organization."

Some Characteristics of Steel

By A. M. LANE, '36

INDUSTRIAL development inaugurated in the latter part of the eighteenth century by the advent of Watt's steam engine was advanced to a marked degree in the succeeding one hundred years. The progress made, however, was limited by a lack of materials with which to work. Many mechanical contrivances built in anticipation of securing advantages in performance or production were discarded because of failures of the machines in initial tests, not as a result of misconceived ideas, but merely because of the absence of knowledge of the physical properties of the materials of construction. Again, many ideas were wasted owing to size limitations decreed by the then known properties of the available materials.

The press of inventive development sponsored inquiry looking toward expansion of construction possibilities. Research into the nature of metals, especially iron-base alloys, carried forward from the late nineties into the current century bore fruit in the development of a vastly increased selection of metals possessing high resistance values. Continued study and experimentation evolved a science for exhaustive investigation into the nature and characteristics of steel, and discoveries were made in the course of time of several alloying agents whose incorporation greatly enhance the physical properties of the resulting alloy steels. The machine age of today is the result of this new availability.

During the early stages of investigation, knowledge of the adaptability of specific alloys to particular services was the exclusive property of the investigators and manufacturers of steels. It was not then, as now, general practice to give widespread pub-

Editor's Note: A. M. Lane, Mechanical Engineering student, has drawn on his considerable practical experience and research for a series of articles of which this is the first.

licity to the findings. It was commonly accepted practice for machine designers and builders to explain their desires to representatives of steel companies and obtain their recommendations as to the materials to be used in the respective members of the machine. Obviously, the steel manufacturer bore the burden of each failure, and the designer or builder enjoyed the fruits of each success. Such procedure was hardly satisfactory to the steel man, and, although service recommendations are still freely made, the burden of success or failure is now carried by the designer. Today, industry demands, and especially so in large scale production plants, that the designing engineer shall have a thorough knowledge of the properties of the metals of construction and that he shall, himself, be able to determine the correct choice of materials. The properties of steel and alloy steels accrue from methods of manufacture and subsequent modifications associated with handling and heat treatment. An insight into the derivation of specific properties is offered in the outline of characteristics of steels that ensues.

Each phase of steel making and shaping has its contribution to make to the characteristics of the final product, but space does not permit of a digression into all of the affecting factors. The properties which are acquird by a steel as a direct result of its conversion from pig iron to steel ingot, from ingot to bloom, from bloom to billet, from billet to forging or finished bar must be generally omitted. The assumption will be made that, so far as the designing engineer is concerned, any steel which he may select for a specific purpose has been accorded proper pre-delivery treatment by the manufacturer; and attention will be focused upon the further development of properties through subsequent heat treatment.

Steel may be defined in any of several ways. If the basis of definition be the method of refinement, then steel is a ferrous metal, produced from pig iron, which has been subjected to a refining process by complete fusion. When the basis of definition is chosen relative to the combined physical and chemical identification, steel is a complex mechanical mixture of numerous elements and chemical compounds. The chief components of the mixture are iron or ferrite, carbon, and manganese; the lesser constituents being phosphorus, sulphur, silicon, oxygen, and traces of hydrogen and nitrogen. These lesser associates of the mixture are all classed as impurities and are generally regarded as undesirable but unavoidable. Irrespective of the manganese component, the iron-carbon relationship is complex. The macro-structure (the structure visible to the naked eye) does not expose this complex arrangement; but it is readily observed in the micro-structure (the structure made visible by high resolution under the microscope) after intense polishing and subsequent etching with dilute acids or other cor-

rosive mixtures. The complexity is identified in steel slowly cooled from a high temperature as a mixture of free ferrite, pearlite, and cementite.

The commercial refinement of pig iron is accomplished by any of five methods or processes, oxidation being the fundamental principle of all save the electric furnace process, which invokes both oxidation and reduction. Essentially, air and iron oxide are the available substances necessary to purification by oxidation, and the employment of either substance requires different apparatus. The method which utilizes air is called the pneumatic or Bessemer process, while that requiring iron oxide is identified as the open hearth or Siemens' process. Either method may employ oxidation exclusively, whence it is classified as an acid process; or it may utilize oxidation in conjunction with strong bases, whence it is determined as a basic process. Both processes remove carbon, silicon, and manganese from the pig iron, but further refinement by removing phosphorus and some of the sulphur is achieved in the basic process. The composition of ores found in this country is such that, of the five possible modes of refinement (electric furnace, acid Bessemer, basic Bessemer, acid open hearth, and basic open hearth), the two best adapted to purifying the pig iron produced from the ores are the acid Bessemer and the basic open hearth processes. These two are the methods most generally employed.

From an engineering standpoint, the interrelation between components of the steel aggregate has as a center of importance the effect of the contained carbon upon the carrier, ferrite. That carbon does exert a profound influence upon the physical properties of the final product is evidenced by the remarkable increase in ultimate strength that accompanies very slight additions of carbon to a given steel. An evaluation of this significant influence is best secured through a knowledge of the characteristics of ferrite and the iron-carbon compound, cementite. The phenomena attendant upon heat changes is, likewise, a fruitful source of investigation of their properties in combination, and the iron-carbon constitution diagram, Figure 1, is of material aid in the study of these phenomena.

Ferrite, carbonless iron, is normally soft, ductile and relatively weak having an ultimate tensile strength of 40,000 pounds per square inch with an elongation of about 40 per cent in 2 inches. Under ordinary conditions of heating and cooling, it exhibits little, if any, tendency toward hardening, that characteristic being developed only under circumstances of extremely rapid cooling from fusion temperatures. It is easily magnetized but its retentivity is negligible. In a microscopic structure thrown into relief by etching with dilute alcoholic nitric or picric acid, it appears white in color; and, depending upon the amount of carbon present in the conglomerate, it

may appear both as a constituent of pearlite grains and as network surrounding the grains, or as wholly associated with the pearlite.

Cementite is a compound of ferrite and carbon, Fe_3C, consisting of 6.67 per cent carbon and 93.33 per cent iron. Its properties are very little known, except that it is an extremely hard and brittle substance and has a tensile strength of approximately 5000 pounds per square inch. In a polished specimen etched with dilute picric acid it stands in relief and shows brilliantly white under the microscope. Cementite, like ferrite, is dependent upon per cent carbon content for its appearance or distribution. In steels containing less than 0.85 per cent carbon its presence is confined to association with pearlite grains, whereas in steels of higher carbon content it is also seen as fine needle-like spines or as network surrounding the grains of pearlite. Its orientation in this latter case is dependent upon the rate of cooling to which the steel is subjected.

Pearlite is the product of a phenomenon of steel conglomeration that is not at all understood. While steel is being slowly cooled from temperatures above certain critical ranges, a precipitation of ferrite and cementite occurs; and these solidified grains collect in distinct bodies to form, at about 700°C., a mechanical mixture containing approximately seven parts of ferrite to one part of cementite. The constituents collect, each to its kin, and array themselves in stratified layers, the resulting grain formations acting as diffraction gratings and giving rise to a play of colors, when observed under the microscope, suggestive of mother pearl. If the cooling rate be accelerated, the pearlite formation will deviate from this typical composition of alternate layers of cementite and ferrite. There are known to be at least five different modifications, each of which retain somewhat the typical identity. Normal pearlite has a tensile strength of 125,000 pounds per square inch and an elongation of 10 per cent in two inches. Because of its property of forming distinct grains or crystals, always containing the same definite percentage of carbon and ferrite, and because of its definite temperature of formation, it is regarded as a separate and distinct constituent of steel.

The effect of each of the three constituents upon the properties of the resultant product of their amalgamation may be summed up in their individual relation to static strength. Free ferrite has a minimum tensile strength with low ductility; free cementite, in association with a ferrite matrix, imparts added hardness and brittleness but detracts from the tensile strength. The conclusion is inferred that increasing the amount of pearlite predicates an increase of static strength with a corresponding decrease of ductility. Since pearlite has a definite ratio of combination, carbon with ferrite, increases of carbon per cent beyond the requirements

of pearlite formation imply increases of hardness and decreases in static strength. In any event, the structure is dependent upon carbon content for its characteristics. The influence of carbon upon the strength and ductility of steel is shown graphically in Figure 2. Examination of this relationship shows that 0.6 per cent carbon gives about the best combination of strength and ductility for steels subjected to severe service.

The intricacy of functional relationship between constituents is not at all depreciated by structural modification attendant upon heat treatment. Rather, the complications are enhanced by phase changes separately induced by temperature state and time rate of contraction of heat from the mass. Then, too, the per cent carbon contained in the steel bears a definite influence upon the temperature of phase change occurrence. The transition from liquid to final solid state involves the elements of time. Certain physical changes occur during the transition period, each of which lags behind the temperature drop that sponsors it, and each of which requires the elapse of time for its completion. The various intermediate phases established during the transformation have stability only within limited temperature ranges. Two of these four phases have their occurrence coupled with the existence of iron in allotropic forms. The other two are associated only with restricted physical rectifications.

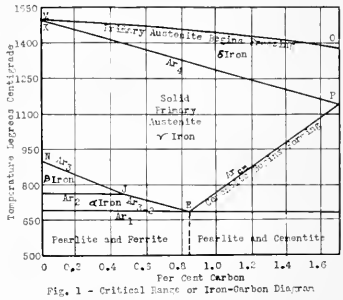


Fig. 1 - Critical Range of Iron-Carbon Diagram

Figure 1 is of material aid in an investigation of the structural variations affected by temperature increase or decline. Likewise, it serves admirably to depict the influence of contained carbon toward distortion in transformation temperature gradients. The initial influence of carbon as an alloy with ferrite is to lower, in proportion to its presence, the fusion temperature of the amalgamation. The temperature of primary solidification of liquid steel has, therefore, the affected range defined by the line M O.

The liquid phase existing for temperatures above the liquid curve consists of ferrite in a homogeneous solution with finely dispersed carbon. Upon dissipation of heat through cooling to a temperature state coincident with the liquid curve, M O, the solution begins to crystallize and solidify, rejecting along the liquid curve crystals of an iron-carbon solid solution. This new state is as peculiar of generation as is any other phase of existence of the alloy. The rejection is not one of homogeneity, for, irrespective of the amount of carbon dissolved in the

liquid phase, the first crystallization is almost entirely of iron—typical of the rejection that might be anticipated from a solution of the consistency indicated at X. The process continues out of harmony along the abscissa corresponding to per cent carbon until solidification is completed at the temperature at which the abscissa intersects the line M P. As the original crystals were richer in iron, so the final formations are richer in carbon than is the liquid. These latter crystals are of the same order as would be expected from an alloy having the richness in carbon indicated by the composite intersection of the complete solidification temperature ordinate with a per cent carbon abscissa at the liquid curve.

The iron existing during this transition from liquid to solid state is identified as Delta iron, an aggregation of non-magnetic atoms arranged on a body-centered cubic space lattice. The carbon of the solution has been shown to have a preference for the liquid state. When the temperature of complete solidification is reached, the arrangement of non-magnetic iron atoms becomes unstable, and further cooling of the mass results in conversion of the iron into another of its allotropic forms. In the new state, the atoms, while remaining non-magnetic, take on a new arrangement—the space lattice being face-centered cubic; and the name Gamma iron is applied to the new state. Immediately upon solid solidification the carbon is found to have undergone remarkable dispersion and to have entered into a perfectly homogeneous solid solution with the Gamma iron. Apparently, Gamma iron has the property of dissolving carbon up to a maximum of 1.7 per cent at a temperature of 1120 C. It does not seem that Delta iron shares this trait. However, since it is not known if the diffusion is under progress during solidification or occurs simultaneously with the change of the iron from Delta to Gamma state, no definite conclusion can be drawn. Similarily, it is difficult to imagine the exact relation of carbon in the distortion of the solidification curve, M P.

This new state of aggregation, generally termed primary austenite, has stability within the temperature ranges described by the lines N J, J E, and E P. Decomposition of the austenite is highly functionary. Upon the rate of heat extraction are based the criterions for an extended series of structural arrangements and modifications. Upon the amount of carbon dissolved in the Gamma iron is dependent the orientation of the ferrite and cementite constituents of the final product. For the purpose of simplification, early consideration will be given only to the structures accruing from slow cooling. There are three general types of ultimate state that may be reached as a result of cooling at rates sufficiently slow to permit free formation of natural grains. The state changes which are associated with the particular steels that give rise to the

formation of these final states of aggregation are consummated along certain lines to which have been given the respective designations: Ar_3, Ar_{3-2}, Ar_{cm}, Ar_2, and Ar_1.

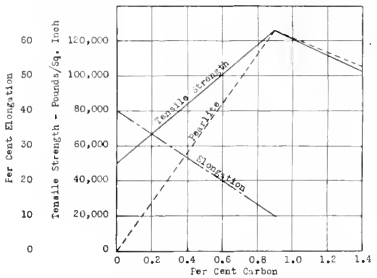


Fig. 2 - Approximate Influence of Carbon upon Strength and Ductility of Steel

Irrespective of carbon content all steels undergo initial alterations upon being slowly cooled to a point of transformation along Ar_3 consistent with its composition. (1) The iron there undergoes a reversal of crystal structure, returning to the body-centered cubic arrangement of the atoms such as exists in Delta iron. (2) The metal, which above Ar_3 was contracting, undergoes a sudden and marked expansion, amounting to an increase of approximately one-thousandth in each linear dimension, which is followed almost immediately by a rapid contraction to normal size. (3) A return from high electrical resistance values toward normal conductivity is started and proceeds uniformly until atmospheric temperature is attained. (4) The property of the iron to dissolve carbon is greatly diminished.

Steels containing less than 0.35 per cent carbon differ only slightly in phase formations below Ar_3 from those in which the carbon range approaches 0.85 per cent. At Ar_3 there is a formation of a cementite of iron in which the valence of carbon is low, this primary cementite having the formula FeC. Subsequent cooling of the mass inaugurates a rejection of ferrite crystals along Ar_3 with a corresponding increase in the valence of carbon and eventual formation of the secondary carbide, Fe_2C. Upon reaching Ar_2 the principal modification of characteristics involved is a transformation from a completely non-magnetic substance to one with strong magnetic properties. Continued cooling brings about the final change in carbon valence and the consequential readjustment of the cementite to Fe_3C when the remaining solution has reached the carbon concentration—temperature state point E. At this point there occurs a simultaneous precipitation of all the remaining iron together with the iron-carbide, Fe_3C; and the eutectoid thus formed consists wholly of grains of the aforementioned interstratified layers of ferrite and cementite—pearlite. The excess ferrite which has been previously rejected does not enter into the formation of the pearlite. Rather, it collects as network surrounding the pearlite grains.

In passing through Ar_3, the ferrite assumes a temporary phase existence indicated as Beta iron on the diagram. It requires more than ordinary stretching of definition to gain allowance of classification of this phase as one in-

volving the creation of an allotropic form of iron different from that existing in the phase state below Ar_3. The essential differentiation between Beta and Alpha irons is one of magnetization propensity and, other than the note already given above, the phase transition from Beta to Alpha can't be generally ignored.

The change which occurs at the time of precipitation of pearlite, likewise, does not involve the establishment of an allotropic form of iron different from Alpha iron. Nevertheless, it does preclude passage through Ar_1, an alteration of considerable importance. The effect of the passage is bound up in the following sudden changes in properties of the steel: (1) A dilation takes place which is effected by carbon content and which reaches a maximum with 0.85 per cent carbon. (2) Increased magnetism is effected for all steel on cooling through this point. (3) A marked decrease in electrical resistance is induced by cooling through this range. (4) On passage through Ar_1, iron loses its property of dissolving carbon in quantities greater than 0.05 per cent.

For steels containing carbon in per cent variations on the range from 0.35 to 0.85, the transition from austenitic phase to Alpha phase is identical with that of steels of lesser carbon content except that rejection of ferrite and formation of iron-carbides takes place entirely along Ar_{3-2} and that existence of the Beta phase is never established.

Beyond 1.7 per cent of contained carbon the constitution diagram is incomplete for the reason that conglomerates containing greater amounts of carbon fall into the cast iron category. Steels of composition such as to fall within the carbon range from 0.85 to 1.7 per cent undergo transformations similar to those already discussed for steels of lower carbon content. Moreover, the manner of solidification from the liquid state does not hold true with increased per cent of carbon. The transition from austenite to Alpha state occurs in an analogous manner, but it is along Ar_{cm}. The product of rejection, however, is not ferrite. Since there is present in any of these steels an amount of carbon in excess of that required for pearlite formation, the free ferrite ordinarily rejected combines with the excess carbon and the expulsion is one of cementite. The exclusion of *surplus* materials continues, as before, until the solid solution attains eutectoid [1] concentration, whence the typical precipitation of the unrejected solution occurs simultaneously with passage of the entire aggregate through Ar_1. The precipitation yield is, of course, pearlite; but no free ferrite occurs in the grain boundaries, the network surrounding the pearlite grains being composed entirely of cementite.

1—*A solution having definite composition of constituents that solidifies from the liquid state called an* EUTECTIC. *An* EUTECTOID *differs from an* EUTECTIC *only in that the freezing is one from a state of solid solution rather than from a liquid state.*

Finding Work

By S. S. BOARD

Condensed from Mechanical Engineering

SECURING employment is the first task that a college graduate faces. The techniques of finding work have been tried repeatedly and, while there may be variations in the end, the same procedure must be adopted. The suggestions which follow are a restatement of the whole process which must be followed in finding work when it isn't easily available. By a careful check of the details, some of the little things which cause difficulty will be found. They are important enough to make the difference between success and failure. An engineer especially must be well versed in these facts because he is so often employed for individual jobs. On the whole, men of comparable grade and ability such as major and minor production executives, salesmen, credit men, purchasing agents, etc., are employed as long as they make good, while an engineer is contracted for a specific amount of work and must keep his eyes open for the next job. For some reason—perhaps because they are more used to studying materials and processes than people—many engineers seem to have little understanding of the fact that there is such a technique as finding work. The importance of making it a study, however, cannot be overemphasized. Essentially the problem is one of salesmanship. The engineer must first determine the value and use of what he has to offer. Then he must find a market, and, finally, he must outline an advertising and selling campaign which will inform possible buyers of the value of his wares in such a fashion as to make them pay real money for them.

Nearly every trained man has two antithetical advantages which, in amounts, are in inverse ratio to each other. Either he has youth and is relatively inexperienced, or he is more mature and has more experience. Young men complain that they cannot get work because they lack experience and older men are discouraged be-

Editor's Note: Albert Schreiber, '38, has edited this article for the ENGINEER. *Copies of the original are available from the A. S. M. E., 29 W. 39th St., New York City, at ten cents apiece.*

cause (they say) the world is looking for young men. Both are wrong. The young man can find certain work where experience is unimportant and the older men can find it where maturity and experience are assets. The mistake both make is in trying to reverse their position. In the main, it is safe to say, that large corporations tend to look for the younger men, while smaller companies or new businesses are likely to seek men of more maturity who can take responsibility rather quickly. However, if you are young, you can sell the idea of youth and enthusiasm and the desire to work under some one who knows what it is all about. If work must be obtained outside your own field it will mean, of course, that your past experiences must be broken down into functions performed in order to discover those easily adaptable to other types of work. In any event the only common denominator between jobs is the activities which are involved in these jobs. Any man who can do fine work in one line can probably do similar work in another line. Engineers are ordinarily found in certain types of work and these can be classified upon a functional basis.

Basically an engineer is an operating man. He gets things done and usually will be in command of a group of men. He is the brains that checks on the labors of others, that corrects mistakes and surmounts difficulties, and that tells how and where and with what tools a task is to be done. In this group come primarily the civil engineers, the construction men, and the mechanical and electrical engineers—men who find that getting jobs is especially difficult in hard times because they are in the capital goods industry. Thus they may have to extend their activity into other fields. It is foolish for an engineer to think that he needs to have a great deal of experience in any particular industry to do the work necessary in that industry. A few years ago a manufacturer of a rather complicated machine wanted a factory superintendent. It was specified, however, that anyone applying for the position must have case-hardening experience, since that was an important part of the manufacturing process. A certain competent engineer felt that he could handle the job even though he did not have such experience. Before applying for the position, therefore, he spent three days in the New York Public Library reading up on all the latest developments in case-hardening. He found out so much about the problems involved that he secured the position in spite of competition with experienced men even though he frankly confessed his lack of actual experience in the field. He did a good job, too. We are sometimes afraid of the bugbear of specific experience. We ought instead to realize that a man with a trained mind who is not afraid to tackle new problems and is not too diffident about seeking information can bring a valuable and often fresh point of view to the solution of problems

that are not properly solved because they are too greatly bound around with tradition.

Another phase of engineering is research. Business men have come more and more to appreciate the practical value of research and scholars engaged in such work are discovering the fact that the pursuit of new knowledge may be profitable financially as well as intellectually. Although much of this work may not be profitable in monetary values or results, if the techniques of research are applied to the discovery of opportunities to be applied with such ventures they will be found not to be more hazardous financially than a host of other occupations. Such work is entitled to be called professional from almost any aspect. Of all the work that an engineer does, however, the nearest to a completely professional status is the consulting engineer. The best consulting engineers are men who have worked on a variety of problems, frequently in various parts of the world, and then after they have had the benefit of this experience, have settled down in some central location. But the present, when we are partly through a depression, is not a time when it is possible for very many to enter this field, and there are other possibilities for enginers which should be given more attention.

One of the principle fields outside of "straight" engineering is sales engineering. Products of a technical nature are increasingly demanding engineers to sell them. Some men pass up such opportunities because they feel selling is peddling. True selling is almost the reverse and consists of so appreciating the problems, needs, and personality of the buyer as to be able to make him see, understand, and want the product being offered him. If the salesman is interested sufficiently in people and is sufficiently interesting to them to get their good will, the rest of the selling techniques can be learned. The most worthwhile selling jobs today pay a salary or a salary and a commission.

Then, too, there are many strange and unusual jobs which an engineer may undertake. These are discovered either by chance or an analysis of the individual's special interest.

With the possible markets for the services of the engineer in mind, the task at hand is to make a personal appraisal in order to determine what work is preferable. The only safe way to do this is to organize it on paper. Your school activities should be analyzed for specific abilities and interests—similarly practical experience, making note of the types of work done, the length of time on each job, and other beneficial information. Next your personal characteristics should be described in as objective a way as possible, depending more upon what other people say about you than upon your own estimates. This will give a good picture of yourself and what you can do best. Then decide what types of work you would like to do in the

future and under what conditions, keeping in mind the functional basis of jobs as previously discussed. Now a statement of your record should be made. This can be a summary of your personal appraisal. Be sure, however, to eliminate most of the details you have accumulated. This summary should not be more than two pages in length and should contain what you want to do, a consecutive chronological experience record, and such details as will complete the picture of the applicant as a man—his birth, education, family status, interests, and habits. It should be typed or carefully printed in ink. Care should be taken in including inquiries and references should be given only when a real job is in prospect.

After you have armed yourself with a summary of your experience, and a decision as to what you wish to do, the next question is where you are to find a job. To do this (unless you literally create one), the surest way is to study the areas of opportunity. Several general fields should be chosen which are geographically accessible and in which you wish to work. For instance, if you are an operating man and wish to go into factory work shall it be steel or glass or textiles or shoes or machinery or automobiles? Each field should be investigated for its financial renumeration, the overcrowding of its ranks with technical men, the times of its busy season, and whether it is an essential industry which cannot be discontinued. This information can be obtained from good newspapers, technical and financial magazines, discussions with business men, and other sources. Then individual companies in the chosen fields should be investigated and information regarding each concern recorded and a list made of the companies in order of desirability of working with them. Now proceed to cover the list. Doing it in person is best—by letter, if there is no other way.

You must go after something definite, however. Don't just ask for a job. Tell your prospective employer that you wish to work for him and what you can do. One employer says, "Many college men out of work have come to office. Some I have helped to get work, many are still looking, but there was one boy who stood out. When he came in he knew what he wanted to do. He presented his desires briefly but enthusiastically. He acted on suggestions promptly. The field he entered has been overcrowded and was dull at the time, but in two weeks he had three jobs lined up."

There are other ways of finding work. No one should be ashamed of using the help of friends, if it is offered, but you should make clear what they can do to aid. There are also employment agencies, public and private, good and bad. You should, of course, be listed with your professional society. Advertisements in the newspapers bring a lot of headaches unless you learn to discriminate between them and are willing to write

repeatedly without getting a reply. In answer to inquiries your letter should be as brief as possible. It should give the information asked for and should be carefully typed so as to stand out for its neatness and clarity. There are some good blind advertisements; but the chances are better of its being a genuine and desirable job if the firm's name and address are given. Blind advertisements are like blind dates—occasionally a "honey" but usually "sour."

One of the most important matters to be decided in applying for a job is the amount of salary. If you can, and unless you know the rate the employer desires to pay, it is better to get him to make an offer which you can accept or try to raise as you see fit. If you must name a price, make it fit the job. It is no use asking too much for a minor job or too little for a good one. Even in these times I have known employers to turn men down because they were too eager for the job and have asked too little. The first thing in determining a fair price is the value of the work to be done. Find out what others are getting and ask about standard prices in employment agencies; but find out the going price for such work. Next, you should consider the policy of the company in question. Is it tight or liberal, prosperous or broke? It is foolish to ask as high wages of a company that is having difficulty as one which is in good condition. The third factor is the impression you make. If the price is not fixed you can count on a difference of at least thirty per cent between the wages paid a man who is diffident or seedy or somewhat beaten and the man who is "on his toes" and confident of himself. Sometimes a man will have a big "front" with nothing behind it, but there is no reason why a man who can do the work should not act as if he himself believed he could. Some day we may have a code of fair salaries for technical men, but in the meantime you must be your own appraiser.

An important point in the preparation for an interview is care in general appearance such as clothes, voice, language, timidity or aggressiveness, and responsiveness to ideas. Of course, there are some things in this category that we just cannot change and these are the points on which men are prone to dwell in their own thinking. We can, however, even with limited means, be sure that our clothes are suitable and in order, that we look well-groomed, that our expression is alive, our faces mobile, our voices resonant and our bearing alert.

Some engineers seem to feel that paying attention to personal appearance smack of the beauty parlor, but that is absurd. Being sure your appearance is suitable is what counts. It is not suitable to apply for an office job looking like a tramp or to ask for work on a relief project looking like a million dollars. You really must dress and act the part in applying for any job.

The critical point of an engineer's campaign to sell himself is "closing the deal." The only satisfactory way to do this is to create a desire and then leave it unsatisfied until the agreement is reached. More men oversell than undersell. If they only knew when to stop talking, they would have a better chance to close the deal.

Back in 1929 an engineer who was working at a job distasteful to him was looking for a better position. Over a two-year period he repeatedly "muffed" about a half dozen opportunities with which he had been put in touch. Finally, after the depression, a good position came open near his home. It seemed as if this was his chance. A friend whom he consulted says, "Then we analyzed his technique together. First he was not properly prepared for the job, and, second, he did not know how to close the deal. The first problem was remedied by a friend in a similar line of work who generously told him all he could about the job. Then he went home, and, at my suggestion, boiled down all his experiences and ideas about the job to a twenty minutes' presentation. I told him, 'When a pause comes in the interview, tell your story, not like a canned speech, but genuinely, as it applies to that situation. When you finish you may find another pause. If you do, get up and leave.' He followed instructions. A committee of four men interviewed him and they asked a few questions. There came a pause and he said to himself (as he told me later), 'Well, here's where I shoot the works.' He did so and again there was a pause, so he arose and said, 'Well, gentlemen, if you want me you can get me on the 'phone. They called at nine that night to make sure they would not lose him."

Personnel men sometimes have to be treated differently. They have certain questions to ask and will not be denied, but if you know your story you'll probably know the answers. In any event, you terminate the interview.

After you secure your job you should not relax in preparing yourself for a better position. Don't be like the farmer who was taxed with the leaks in his roof. "Why don't you fix them, John?" he was asked. "It wouldn't be much work." "Wall" he said, "When it's raining tain't possible, when tain't, tain't necessary." No man can be so sure of his position that he need not do these two things: first, study the possibilities of his present position, and, second, keep in touch with outside activities. It's the well rounded men who are able to meet new emergencies. It's a man's sureness of himself or his individuality that distinguishes him from the rest of the herd. Such a man finds work because he is remembered. Do people say about you, "What was the name of the man we saw last Friday?" or do they say, "Remember that man Jones we saw last Friday?" It's very much up to you; and your career, if not your happiness, may depend on it.

Gypsum, Its Manufacture and Uses

By L. W. BIEGLER, '35

GYPSUM is one of two calcium sulphate minerals that occur rather abundantly in nature. The name, along with many uses for the mineral, has come down from ancient times, but it is sometimes applied to other substances through ignorance of the precise properties of gypsum. It belongs strictly to the hydrated form of calcium sulphate, that is, to the combination of water and calcium sulphate, intimately bound together.

The second form of calcium sulphate found as a mineral in anhydrite, which has no water as an essential constituent. This anhydride resembles gypsum in its methods of occurrence and to some extent in its physical properties, but there is a wide difference in regard to those features which make gypsum so useful for arts and industry.

Gypsum in its pure state contains 20.9 per cent by weight of water and 79.1 per cent of calcium sulphate, or stated in its chemical formula it is $CaSO_4.2H_2O$. In commercial analyses the calcium is expressed in terms of lime (CaO), and the acid in the form of sulphur trioxide (SO_3), the corresponding figures being 32.5 per cent lime and 46.6 per cent sulphur trioxide. Crystals of gypsum, free of foreign inclusions, show a close approach to these percentages. The common rock and earthly forms of gypsum that are employed commercially contain many impurities like clay, iron, oxide quartz, lime, and magnesium carbonates, mechanically held water, etc., the proportions of which in the aggregate range from two or three per cent in the highest grades up to thirty per cent and more in the impure grades.

Editor's Note: L. W. Biegler, student in Fire Protection Engineering, is a member of Tau Beta Pi and Salamander. He is a regular on the Varsity baseball team, and a member of Honor A.

It is also not uncommon to find gypsum and anhydrite intermixed in such a way that the material has the semblance of a homogeneous mass, and and the presence of the anhydrous compound is revealed only by microscopic or chemical tests. The presence of more than one or two per cent of anhydrite is regarded as detrimental to the use of gypsum for many purposes.

The constituent of water, or water of crystallization as it is called, which is an essential part of gypsum, can be driven off by heating the sample. The rate at which the water goes off is more or less a function of the temperature and pressure and by governing the process according to certain physical principles there results products like half-hydrate which have valuable properties that lend to gypsum its most important uses.

Pure gypsum has a specific gravity of about 2.3. The gravity is, of course, affected by the impurities. Rock gypsum, free from moisture, weighs from one hundred and forty to one hundred and fifty pounds to the cubic foot. Gypsum in the ground may be estimated roundly at three thousand short tons to the acre, for each foot of thickness of the deposit.

The softness of gypsum is one of its distinguishing characteristics. It runs about number two in the scale of mineral hardness, between talc, number one, and calcite number three. The crystals of gypsum belong to the monoclinic system and are usually bounded by a simple combination of faces. According to the relative development of the several faces, they are tabular or flattened, prismatic, or elongated needle-like forms. Arrowhead shapes are produced by intergrowth of individuals in the reverse position, so-called twinned crystals.

There are several kinds of gypsum distinguished on the basis of physical characteristics. When bound in crystal sheets, forms common to its occurrence in veins and in loose material like clay, it is known as selenite.

Rock or massive gypsum is the usual gypsum of commerce. It is made up of an intimate intergrowth of small crystals, seldom bounded by plane surfaces but having all other features of crystals, and ranges from a finely granular to a very coarse material in which the individual particles may measure an inch or more across. The nature of the impurities determines the color of gypsum rock, which is commonly gray, brown, drab and sometimes nearly black. The dark varieties often contain organic matter. Reddish gypsum is common in some parts of the west and usually denotes the presence of iron oxide.

The most important commercial source of gypsum is the massive bedded deposits, in which gypsum occurs in one or more seams or layers associated with such materials of limestone as shale and sandstone. The sedimentary series may also include beds of rock salt, but this material is frequently absent. In this type of deposit the

gypsum seams are likely to be persistent and to conform to the other rocks in their structure, following the general dip and strike of the bedded formation. The usual method of extracting the gypsum is by room and pillar similar to that employed in horizontal coal seams. As the gypsum is soft it can be drilled for blasting by rotary auger drills.

The use of gypsum as a manure, in its simple state, was first noticed about the middle of the eighteenth century by a German clergyman, Meyer. There perhaps is no other artificial manure so decided in its effects, so readily obtainable by the farmer, and so plentiful in this country as gypsum with its great amount of lime. Its mode of action is readily understood, for it acts as a direct food for some plants, and has a very slight attraction for the moisture of the atmosphere. It neither promotes the composition of the organic matters of the soil, nor, like those decomposing substances, does it furnish the gases of putrefaction for the service of the plant. There are, in fact, only five commonly cultivated crops which contain gypsum in any sensible proportions, and to which in consequence, it is a direct food; these are lucern, sainforn, red clover, rye-grass, and turnips. It also greatly refreshes the artificial grasses.

Composition of Gypsum

Sulphuric acid	32 or 43%
Lime	30 or 33
Water	38 or 24

Composition of the soil which has proven to give good results is:

Organic matter, chiefly vegetable	3.5%
Soluble matters	3.0
Carbonates of lime and magnesium	19.0
Oxide of iron	2.75
Alumina	8.5
Sand and gravel	62.0

One of the good reasons why gypsum has not been universal in its employment by all cultivators of artificial grasses arises from the fact that many good soils contain, naturally, sulphates of lime in sufficient quantities for the services of the plant, and consequently the application of gypsum to such land is useless. It is therefore important that the farmer have his land analyzed to determine the possible advantage of applying gypsum.

Gypsum is a hydrous calcium sulphate, it grinds to a white powder, is not injurious as a dust, and is fairly low priced, although not as abundant or as generally distributed as limestone. Gypsum producers may accumulate large quantities of gypsum off color or impure gypsum mixed with anhydrite which cannot be marketed through commercial channels. For a dusting material in mines no rigid specifications are laid down, and therefore these waste materials could be sold at a relatively low cost and, at the same time, cut down the number of dust explosions in mines and create a market for the waste materials.

Hard finished plasters are plasters composed of gypsum anhydride mixed

with some salt such as hydrous sodium sulphate, $Na_2SO_4.10H_2O$,or alum before or after calcination. These hard plasters are chiefly employed at the present for finishing walls where a dense, hard, smooth surface is needed, but as some of them have high strength, relatively low porosity and low specific gravity, there is a possibility that they may be also used in building construction. The process should not be expensive since the raw material can be easiiy obtained, crushed, and calcined at relatively low temperature in rotary kilns.

One method of preparation of hard finished plaster is as follows: "The raw gypsum is soaked in concentrated solutions of Glauber's salts, potash alum, and borax. The material after being drained and dried was calcined to 450, 550, 650, and 750 degrees Centigrade. After calcination the plasters were ground and set with the additions of water."

Gypsum is used for various purposes in the arts and industry. A substantial proportion of the present product, about twenty per cent from New York State, is shipped directly

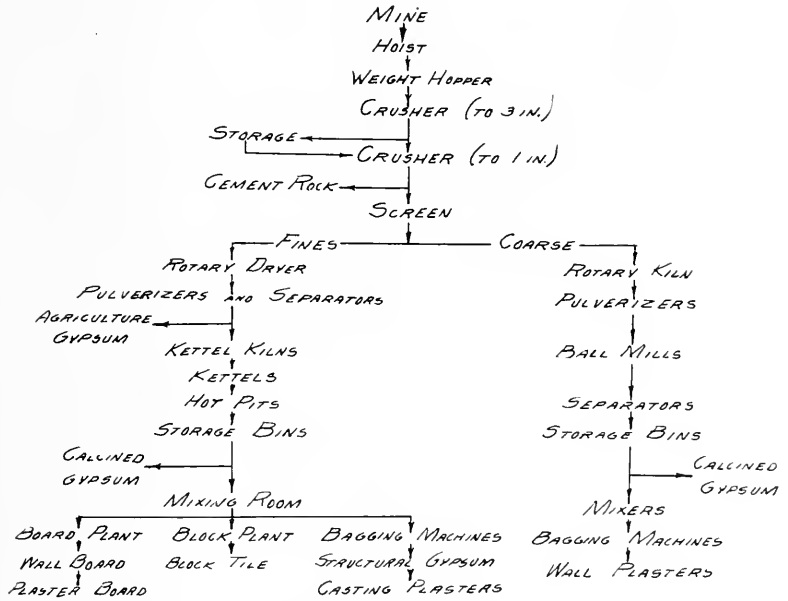


FIG. 1—*Manufacturing of Plasters.*

from mines without preparation other than crushing or grinding. There are many uses for crude rock that are not served by the local material and for which it is not adopted.

The even granular semi-translucent gypsum is employed in sculptures and ornaments, but less commonly in this country than abroad. It was a favorite medium for the early Egyptian artists, as well as those of Greece and Rome, and many beautiful examples of their work are preserved in the museums. Rock gypsum is not well adapted for building stone, but has found limited employment in that way locally where other materials were not available. At one time it is said that the gypsum of Fort Dodge, Iowa, was extensively quarried for structural work and for sidewalks. The stone bleached and cracked more or less on exposure but did not disintegrate to any marked degree.

The first incentive to the gypsum trade was the agricultural demand. Ground gypsum has been applied to farm lands for many years. It is a good absorbant for farm use because mechanically, gypsum tends to loosen heavy clay soils and to retain moisture.

Portland cement of the present day contains up to two per cent of sulphur trioxide, which is added to the mixture to retard the set. Gypsum is the substance universally employed as the sulphur carrier and is generally introduced in the crude state. Raw gypsum is added to the cement clinker and ground with it. It is prepared at the mines by crushing to coarse size, usually so as to pass a screen of one-inch mesh.

Gypsum and anhydrite heated in the presence of air to temperatures of one thousand degrees Centigrade, or above, decompose into lime (CaO) and sulphur trioxide. The latter sulphuric acid anhydride is a valuable commercial product and its preparation from gypsum offers possibilities which have been given serious consideration. In Germany a method is used to grind up the gypsum in a ball mill with coke, clay, and slate, and then to calcine the mixture in a rotary kiln fired by coal dust. Sulphur dioxide is evolved and then is converted into sulphuric acid, and, as a by-product, cement clinker is obtained. It appears also that gypsum is employed in Germany in the manufacture of ammonium sulphate in connection with the Haber process of mixing nitrogen with the air.

Finely ground gypsum is used as a carrier of insecticide compounds. It is also employed to some extent in pharmaceutical supplies. White gypsum ground to two hundred mesh is known as terra alba, which finds application as a paper filler in paint and for other purposes. School crayons are made from ground gypsum mixed with a binder and then compressed.

Calcined gypsum is a general term for the products obtained by subjecting gypsum to heat, and are popularly called stucco, plaster of paris, or ce-

ment plaster. Substantial quantities of calcined gypsum are consumed in the making of casts and molds for scientific, artistic and commercial purposes. Besides scientific molds and works of art, china and porcelain wares are commonly cast in plaster molds.

Plate glass manufacture calls for many thousands of tons of calcined gypsum. The glass sheets are embedded in a plaster matrix during the stages of grinding and polishing. After use the plaster is reground and again calcined and with the addition of a little fresh material is ready for service in the same manner as before. The consumption of gypsum plaster for glass manufacture amounted to about forty thousand tons annually some twenty years ago, and no doubt has grown considerably in this later period.

The requirements of rapid building construction have led to the substitution of gypsum plasters for lime plasters to a certain extent and to the perfection of such articles as gypsum boards, blocks and tiles for both exterior and interior uses. It is this fact that has brought about a remarkable increase in the production of these products. Wall plasters consist of calcined gypsum, a fiber like hair or wood, sand and a small proportion of retardative. Pure gypsum plasters are inherently deficient in plasticity, but this condition is remedied by the addition of colloidal substances like hydrated lime or finely ground clay. Poured gypsum concrete as a material for the construction of houses and buildings is a relatively new departure in the trade. It is claimed that it provides a well insulated fireproof construction at a cost of not more than that of frame buildings. It is used to form the walls of one or two-story dwellings and of one-story factories. Gypsum plaster is made in special grades for insulation of buildings by the addition of certain chemicals which cause evolution of carbon dioxide when mixed with water. The gas is held imprisoned long enough to produce a cellular texture in the set plaster. The latter is very light and an excellent insulator against heat and cold.

Gypsum, we can plainly see, is used very widely. In some places it can not be supplemented by anything which will give the desired results, and in other places it is possible to use other materials which will give much better satisfaction. Changes happen very rapidly and many unknown uses for gypsum may come to light by the revolution of other industries or by chemical analysis and experiments on gypsum itself. It is being used more and more as a building material. It is possible for gypsum products to find a useful place here as an insulator more so than ever. Many people use gypsum products without once thinking from where they originate. It would be surprising to many just how great a part gypsum plays in this unsymmetrical machine of industrial progress.

THE ARMOUR ENGINEER

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GRANTING the possibility of one of the numerous political turnovers so typical of world history since 1914, many observers are nevertheless drawn to the conclusion that Franklin D. Roosevelt will be re-elected in the campaign of 1936 now scarcely more than a year away. His re-election would be either on the accomplishments of his new order, or on the plea that four years is an insufficient length of time to fairly test these principles.

Assuming the truth of this prediction, the election of 1940 would be of more importance than, perhaps, any other in American history. At that

time, every man who reads this expects to be a responsible citizen of the United States, in whose hands an all-important decision lies. Will we be capable of an intelligent answer to the question of a future social order?

It is not the purpose of this article to bandy high-sounding phrases about "His Majesty, the American Voter." The obvious truth is that one vote amounts to very little when compared to the whole, but another obvious truth is that if the experiment in democracy is to succeed, every vote must be taken seriously. It is for this reason that those of us who wish to perpetuate democracy should be fully equipped to do so.

Why not establish a real course in Political Science at Armour, elective to those in the above category? Or why not prepare an intelligent list of easily available reading material on that subject? In these days of propaganda on one side, and scurrilous abuse on the other, intelligent reading is more possible through guidance than through choice.

IN THIS issue of the Engineer are introduced the first articles on two subjects which are to be continued in order to allow for their more complete expansion. Into the two fields most interesting to any engineer, Men and Materials, the articles by Dean Heald and Mr. Lane find their way. Dean Heald has consented to be the first of a limited number of Deans of middle-western engineering schools who will present a symposium of articles on engineering education, a field whose changes in recent and future years are subjects of great interest and speculation.

Mr. Lane, a man of considerable experience in the engineering field before his entrance into Armour, has made an extensive study into the properties of steel. This is a subject which is involved in some way in every department of engineering, and for this reason is felt to be of interest to all the readers of this magazine. A member of the Institute faculty who is himself connected with this field has styled Mr. Lane's first article as the best condensation on the subject that he has seen. It is hoped by Mr. Lane and by the Engineer staff that readers with constructive criticism on the purpose or execution of these articles will advance them without hesitation.

DEAN HEALD, in his article, predicts the reopening of the shops to some extent during the next college year. It is very necessary that some parts of the present Junior class, which is the first to have missed adequate shop instruction, shall be able to complete this important phase of their education before leaving Armour. We sincerely hope that provision will be made in their curricula, and in the available time given in the shops, for this to be done.

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

Structural Design in Steel

By THOMAS CLARK SHEDD

John Wiley & Sons

IN view of the fact that the subject of structural design covers a very broad field, even when it is confined to only one material, the author of this book has attempted to give only the fundamentals of design in structural steel, with the view in mind of assisting not only the engineering student but the young practicing engineer as well. Courses in the theory of simple structures and in mechanics of materials are considered by the author as prerequisites for the user of the book.

The first few chapters in the volume are devoted to a study of the subject in general, and includes a definition and description of each of the three fundamental types of members used in construction work—beams, tension members, and compression members. Photographs of the steel structure of industrial buildings and bridges are employed to illustrate the functions of the members, and in subsequent chapters the design of each of these three fundamental types is discussed in detail. The design of the various connections for beams, columns, etc., the determination of the loads on building and bridge structures, and their design as a whole are also described. A separate chapter is devoted to the study of the various types of welded joints and the stresses in them. In the appendix is included general specifications for the design of steel railway and highway bridges, and the American Institute of Steel Construction specifications for the design, fabrication, and erection of structural steel for buildings.

One of the most useful features of the book is the inclusion of twenty-four sets of actual design calculations, supplementing the discussion in the various chapters. These calculations are in the form of illustrative examples, and are given as representative of those that the practicing engineer would usually make. For the most part, rather complete explanations and comments are given for each set of calculations, so that the reader may follow through the design with ease.

The Physics of Electron Tubes

By L. R. KOLLER

McGraw-Hill Book Co.

AS early as 1700 it was a recognized fact that, in the presence of an incandescent solid, air took on certain electrical properties which it ordinarly did not have; that is, it lost some of its insulating properties and caused charged bodies to lose their charge. Quite a few years later experimenters showed that the charges which were given off by incandescent bodies and caused air to behave in that way were the same as those which were emitted in the presence of ultraviolet light or in cathode rays. It was not until about 1895 that these identical charges were recognized as electrons. At the present time a knowledge of the properties of electrons and their behavior is the basis for the use of vacuum tubes in the field of radio communication and elsewhere.

In this book are discussed the fundamentals of the phenomena which take place within the electron tubes themselves, for the external conditions and vacuum tube circuits are not emphasized. The first chapter deals with the theory of thermionic emission, and includes a discussion of the various equations and effects. Subsequent chapters are devoted to a description of the thermionic emitters containing thorium, oxide coated cathodes, emission from caesium, and secondary emission. Methods of determining the temperature of the emitting surface, space charges, discharge in gases, and photoelectric effects and properties are also discussed. The appendix includes the derivation of the equations of Richardson and Schottky, as well as problems for the student.

The author has attempted to present the material in such a way that it will be both valuable and interesting to engineers and to students who have not taken any special courses in electronics.

The Methods of Cellulose Chemistry

By CHARLES DOREE

D. Van Nostrand Company

DURING the past fifty years various specialized methods have been devised for investigating experimentally the properties of cellulose in all of its aspects—as a constituent of plant cells, as a chemical substance, and as a structural colloidal unit. Descriptions of these methods have appeared in various articles and even in textbooks, but few efforts have been made to collect the material into one volume for ready use. The author of this book has therefore selected the best of these processes and described them, for the purpose of assisting both the student about to undertake research in the field of cellulose and the workers in laboratories concerned with

the manufacture of cellulose products.

The subject matter in the book is divided into three parts, the first of which deals with normal cellulose. In the second section methods for the preparation and determination of the properties of synthetic derivatives of cellulose, such as cellulose nitrate, xanthate, and acetate, are described in detail. Methods for the investigation of the compound cellulose are taken up in the third part.

In each of these sections the author has given the full working details of the best methods from various sources, and has illustrated their use by abstracts taken from the original investigations in which they were employed. The book contains numerous drawings of apparatus, tables, and graphs.

Termites and Termite Control

By CHARLES A. KOFOID, etc.

University of California Press

IN view of the increasing damage done by termites in various sections of the country during recent years, the Termite Investigations Committee was formed in California in 1928. The work of the various scientists and investigators who compose the committee and their report of progress to the latter is the basis for this book, which is now in an enlarged and improved second edition.

The first of the four sections into which the subject matter of the volume is divided is concerned in general with the biology of termites. In it are discussed the constitution and development of the termite colony, the external and internal anatomy of termites, protozoa in them and the hydrogen-ion concentration in their intestines, and the association of termites and fungi. Several chapters deal with the effect of climatic conditions on the occurrence of termites and factors tending to limit their distribution. A good deal of this section is devoted to a discussion of the biology, habitat, distribution, and economic significance of subterranean, dry-wood and damp-wood termites in the various parts of the country. The discussion also pertains to the importance of termites in Hawaii, Mexico, West Indies, Panama, and the Philippine Islands.

Chemical investigations in relation to termite control comprise the second section of the book. Here are discussed the effects of various chemicals on the life of the termite, and the various methods of application of the substances. The third part includes a discussion of the termite resistivity of wood and building materials, with reference to the effectiveness of various treatments. In the last section means for the prevention and repair of termite damage by proper construction and by the treatment of materials are taken up in detail.

The book contains a rather lengthy bibliography, and the tables and illustrations are of especial interest.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

INTEREST in Alumni affairs reached its height last November, when well over 300 alumni, faculty members, trustees, and Tech friends met at the Medinah Athletic Club for their fall meeting and banquet.

At this meeting it was voted to hold over the election of Alumni officers until Autumn 1935; also to change the constitution to conform to the new amendments adopted in times past, and to eliminate some of the many officers (forty-one at present) and concentrate the management of Alumni affairs in fewer hands.

James D. Cunningham, Chairman of the Board of Trustees, and President Willard E. Hotchkiss presented a few remarks concerning the condition and future of Armour Institute of Technology. Secretary D. P. Moreton, who devoted much time and energy towards making this meeting a success, read his report on the financial condition of the Alumni organization; and John J. Schommer, who presided over the meeting, displayed his usual amount of ability in coordinating the discussion of the assembled alumni.

* * *

The twenty-fifth anniversary of graduation of the Class of 1910 will be celebrated at the Spring banquet to be held some time this coming June. It is hoped that all alumni will assist in making this affair a huge success, and perhaps that 5, 10, 15 and 20-year commemorations will be planned for this big occasion.

* * *

Mr. Clarence W. Farrier (Arch. '16) has been appointed Coordinator of the Development Organizations of the Tennessee Valley Authority and will be located at Knoxville, Tenn. This is one of the important departments of the TVA, and under Mr. Farrier's direction will be conducted investigations and research in Engineering, Forestry, Soil Erosion, Transportation, Power, Industry, Agriculture, and Social and Economic problems in the full development of this venture.

Mr. Farrier, before taking over his duties in the Tennessee Valley, was connected with the Century of Progress, having had responsible charge of planning, design, construction, and operation.

* * *

Mr. Tirrell J. Ferrenz, (C. E. '11) has been recently appointed as director of the Land Use Survey and Real Property Inventory sponsored by the Metropolitan Housing Council of Chicago.

Mr. Ferrenz will direct the work of assembling up-to-date information and

basic data concerning the use of land in the metropolitan area and the type and condition of the buildings on the land, as well as population changes and economic trends in each part of the region.

This work, costing between $500,000 and $750,000, will extend over a period of four months, and several thousand men and women will be employed.

* * *

Kent H. Parker, F. P. E. '28, has recently been appointed assistant professor of fire insurance on the Armour faculty.

* * *

Jerome B. Dirkers, F. P. E. '32, was employed for the first two and one-half years after his graduation by the Kansas Inspection Bureau. Mr. Dirkers has recently left this position to become an engineer for the Western Factory Insurance Association.

* * *

One member of the class of '27, Morris B. Rothrock, who was formerly with the Illinois Inspection Bureau, has been appointed engineer for a general agency in Boston.

* * *

Among the air-minded graduates of Armour is George A. Kloepfer, C. E. '29. Shortly after graduation from Armour he enlisted in the navy and spent a year in flight training at the Great Lakes and the Pensacola, Florida, naval station. Following his training period he went to the west coast and remained with the Pacific fleet for a year. He has now retired from regular naval duty but remains active in the naval reserve. At this writing he is at the Great Lakes naval station for his annual fourteen-day training flight.

Mr. Kloepfer is preparing a thesis for presentation to the civil engineering department in accordance with the requirements for a professional degree, which he hopes to receive in June.

John J. Schommer, President of the Alumni Association, has been meeting with several out-of-town Alumni groups during the past few months. On January 22, 1935, he spoke for two hours addressing the Detroit Alumni on the affairs of their Alma Mater. The following men were present: Howard M. Raymond, President Emeritus; E. D. Merry, E. E. '03; R. W. Judson, M. E. '04; I. J. Turnball, M. E. '07; H. S. Ellington, C. E. '08; R.G. Grant, E. E. '08; G. G. Parry, M. E. '09; J. H. Kuehne, E. E. '11; C. W. Collins, C. E. '12; P. L. Keachie, M. E. '12; C. D. Lundblad, Arch '13; A. N. Koch, M. E. '14; J. W. Turner, E. E. '14; A. L. Petersen, C. E. '15; A. R. Mehrhof, E. E. '21; C. Frink, C. E. '23; F. R. Nelle, C. E. '24; R. S. Walsh, F. P. E. '27; N. Cottington, F. P. E. '28; R. H. Osborne, F. P. E. '28; J. J. Reifler, F. P. E. '28; R. E. Phelps, F. P. E. '29; S. A. Beatty, F. P. E. '30; M. C. Berg, F. P. E. '30; H. W. Mullins, F. P. E. '30; J. J. Zolad, Ch. E. '30; P. H. Kesselring, F. P. E. '31; R. H. Kutteruf,

F. P. E. '31; C. A. Nelson, F. P. E. '33; S. A. Vanderpoorten, F. P. E. '33; B. H. Peterson, F. P. E. '34; and C. H. Lundblad, Arch '16.

* * *

Doctor Raymond talked briefly about his former associations at Armour Tech; and John Schommer held his audience with a most interesting outline of the history of the development of Armour Tech from 1921 to 1935, bringing out many points relating to the trustees, the professors, President Hotchkiss, and how the vast deficits of previous years have been cut down to a deficit this year that can undoubtedly be raised to perpetuate the Institute.

The new officers of the Detroit Alumni are Stanley A. Beatty, President, and H. W. Mullins, Secretary and Treasurer.

* * *

F. D. Payne, F. P. E. '28, and former captain of the track team at Armour, was host to a small group of Alumni at his home in Indianapolis, on February 23, 1935, and John Schommer talked to them about the affairs of their Alma Mater.

Among the guests who enjoyed themselves until about 1:00 A. M. were: J. L. Schmidt, F. P. E. '07; W. P. McGuire, E. E. '11; E. E. McLaren, F. P. E. '24; C. W. Barger, F. P. E. '26; J. A. Davidson, F. P. E. '26; E. R. Hubbell, F. P. E. '26; R. E. Baur, E. E. '27; D. B. Davidson, F. P. E. '27; R. S. Walsh, F. P. E. '27; C. S. Chandler, F. P. E. '28; W. J. Buggy, F. P. E. '29; J. W. Gamble, F. P. E. '29; and E. C. Erland, F. P. E. '31.

* * *

D. P. Moreton, John J. Schommer, and W. N. Setterberg attended a two-day conference of the American Alumni Council held at the University of Chicago on February 1 and 2, 1935. Delegates from colleges and universities in the middle-west met for the purpose of interchanging ideas on common problems incident to alumni work. The discussion brought out many interesting points on matters pertaining to membership, collection of dues, alumni magazine, alumni endowment, alumni representation on boards of trustees, and alumni scholarships.

THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Track

THE seventh edition of the Armour relays on March 16 brought another outstanding field and another full house. Results, not available at press time, were almost sure to show several new records established in what is fast becoming a feature event in the American track program.

After a rather unlucky start, when Loyola nosed them out by two points, the Armour trackmen settled down to the grind of a more successful season. The veteran, Captain Roberts, demonstrated his versatility in the first meet and is heavily banked on as a point-getter. Ex-Captain Nelson, Neal, Concolino and Fleig feature a squad which is especially bolstered by members of the Freshman team, which won the interclass meet.

Baseball

WITH George Earnshaw and Ed Baumel pitching within a few blocks of each other, things look promising for a successful season on the south side. Unlike their unlucky neighbors, however, Armour's baseball team can look back on the 1934 season without a headache. The Tech boys finished second in the Northern Collegiate Association last year, and hope to improve their rating by one notch with a well-balanced 1935 squad. Battery men have been working in the gym since early in February.

Swimming

THE Tech tankmen have not as yet this year gone to town, but it is hoped, not without some degree of hesitation, that they will make a better showing as the season progresses and will endeavor to bring up a rather bad record. Special mention is due Captain Johnny Ahern, whose endeavors have helped pull Armour out of many a bad hole, and whose doggedness has kept up the morale of the team.

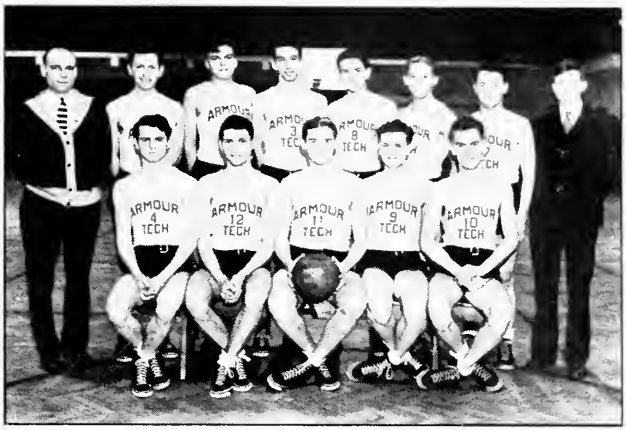
Wrestling

THE Tech wrestlers have embarked upon a successful season and from all appearances they intend to keep it up. The Freshmen are ably represented by two of the most promising wrestlers that have worn the yellow trunks in the last few years, namely, Jimmy Dunne and Mel Schuman. Under the expert captaining of Bob Schmidt, and the conscientious tutelage of Coach "Sonny" Weissman, things are sure to happen.

Basketball

NOT content with laying a foundation for what should be one of the Mid-West's best teams next year.

Rear:
Krafft, Levy,
Brown, O'Brien,
Doane, Christoph,
O'Connell,
Humiston.
Front:
Dollenmaier,
Merz, Lauchiskis,
Heike, Warner.



the 1934-35 Armour cage squad turned in a fine record of eleven wins and five losses for the season. Three of the defeats came in the last week, so it is apparent that until then the Tech men had been almost unbeatable.

Features of the year were the 37-31 trouncing given to De Pauw, which, on the very next night, dropped a heart-breaking one point game to Wisconsin, Big Ten co-champions, and the hair-raising finale in which the Hawks lost to Indiana State Teachers, 48-43, after having led the big, smooth-working Hoosiers at the half.

Credit for the year is divided among all. Coach Krafft, Manager Humiston, and Captain Lauchiskis stand in the fore. Seniors playing their last year were Christoph, Doane, Lauchiskis and Levy, but even these stalwart veterans had to concede the palms to the smooth Junior guards, Dollenmaier and Warner, and to the big Sophomore pair, high-scorer Heike and high-jumper Merz. The Freshmen, O'Brien and O'Connell, of whom more will be heard, stood out in minor roles, the former, especially, seeing frequent service.

Pi Tau Sigma

PLEDGING for the spring semester was the principal topic of the meeting held on March 6. As suggested by several of the members, pledging is being done earlier this spring than in the several previous, in order to give the new members maximum time in which to enjoy the facilities of the fraternity.

The principal campus activity of the chapter has and should continue to be in the line of cooperation with the local branch of the A.S.M.E. Professor Roesch, faculty adviser in both organizations, has contributed prominently in bringing about this coordination.

Eta Kappa Nu

THE men of Eta Kappa Nu have been lost in the maze of the fifteenth harmonic of the existing current of a transformer, and have found it practically impossible to maintain their batting average in chapter activties. With that out of the way, the call to work has been sounded and, as a result, the appearance of certain chapter rooms has improved greatly. Those in the know say that plans are in the air.

Chi Epsilon

AT their annual business meeting the members of the civil engineering honorary fraternity elected their officers for the coming semester as follows:

President . . . K. O. Stocking
Vice-Pres. . . J. M. O'Connor
Secretary . . . . . G. A. Nelson
Treasurer . Dean H. T. Heald

R. R. Johnson was appointed assistant editor of the "Transit," a monthly publication of the fraternity. The plans for this semester include the compiling of an alumni index, in an effort to have more alumni present at the meetings of the organization.

Phi Lambda Upsilon

THE members of Omicron Chapter of Phi Lambda Upsilon are now busily occupied with the preparations and plans for the annual spring pledging. Averages are being compiled, and the lucky wearers of the pledge ribbons will be announced at a not too far distant date.

At the last business meeting, before press time, the chapter voted on a change in the constitution of the national organization, and at the same time devoted a few minutes for a discussion and a vote on revising the design of the fraternity's key.

American Society of Mechanical Engineers

MEMBERS of the Armour Branch of the A. S. M. E. who attended the annual smoker held earlier in the month were entertained by three fifteen-minute talks on engineering subjects. The speakers, W. W. Henning, A. M. Lane, and H. L. Mayerowicz, were selected at an election on the basis of short talks which they have presented during the last semester. The best of the speakers will then represent the Armour Branch at a contest which is part of the annual A. S. M. E. convention which is to be held on April 27.

At a recent meeting of the society it was announced that a "Handbook of Chemistry and Physics," donated by Professor Roesch, will be awarded to the student showing the greatest activity in the A. S. M. E. during the year. At this same time plans were discussed in regards to an inspection trip to the Milwaukee plants of the A. O. Smith Manufacturing Co.

American Institute of Electrical Engineers

ON February 1, the Armour Branch of A. I. E. E. was privileged to hear an especially talented speaker in the person of Mr. Carl Miller, an engineer of the Weston Instrument Co. His subject was the "Weston Photronic Cells and Their Application in Industry." To add to the general high calibre of the talk, Mr. Miller displayed numerous instruments and explained their uses. Other speakers have been heard upon previous occasions, but the lecture given by Mr. Miller was outstanding.

American Institute of Chemical Engineers

IN accordance with a custom of many years' standing, the senior members of the A. I. Ch. E. have recently rendered their solution of the annual contest problem and are eagerly awaiting the decision of the judges. During the interim they have had the pleasure and good fortune to hear splendid talks given by Dr. L. M. Tolman, head of the research department of Wilson & Co, and Mr. S. O. Clark, head of the Food and Drug Administration of the Central Section. The former discussed the chemical engineer and his relation to the food industries; while the latter attacked the subject of "Food Chemistry as Applied to the Food and Drug Act." An address by Dr. C. W. Balke on "Tantalum Alloys" is to be given on March 1, and its delivery is being awaited with a great degree of anticipation, the more so due to the prominence of the speaker, who, beside being a former instructor at Kenyon College, the University of Pennsylvania, and the University of Illinois, has done much valuable research work in the determination of atomic weights and in the study of metallic cerium, tungsten, and tantalum.

Western Society of Engineers

CONSTRUCTION work is almost completed at Boulder Dam, and this work was explained at an illustrated lecture given by R. A. Kirkpatrick at a meeting of the W. S. E. Wednesday, February 27, at 10:30. Colored slides were used to show scenes of construction.

Mr. Kirkpatrick, a graduate of the University of Iowa, is president of the National Americanism Congress, successor to William H. Taft. He is also a member of the Advisory Council on National Parks of the Isaak Walton League.

In the near future a lecture will be given by J. W. Woermann, civil engineer of the Federal Government on the Illinois Waterway system.

All of the students are invited to attend these lectures, and also those given under the Junior section of W. S. E. on the third Thursday of each month at the Engineers building in Chicago.

Sphinx

The honorary literary society, Sphinx, takes pleasure in announcing the recent initiation of the following men:

J. M. Bard, '35.
C. R. Bristol, '35.
J. F. Humiston, '35.
O. P. Freilinger, '35.
J. K. Morrison, '35.
F. D. Cotterman, '36.
R. R. Johnson, '36.
R. S. Kercher, '36.

Salamander

The honorary Fire Protection Society initiated the following men:

C. R. Bristol, '35.
L. R. Kerlin, '35.
R. A. Peterson, '36.
W. A. Trudelle, '35.
H. J. Zibble, '36.

ENGINEERING PROGRESS

NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

Fuel Oil Heater

THE new type of fuel oil heater recently placed upon the market has several unique advantages which provide an exceptionally flexible and compact installation.

This apparatus consists of two parallel steel pipes, each serving as a shell for a single G-Fin Pipe with a return bend at one end and all inlet and outlet connections at the other end. The pipe is made in the form of a U-bend, each leg of which is contained in one of the two parallel pipe shells.

The units can be arranged in series or parallel because they are both standard and interchangeable. Additional sections can be connected at any time to the existing installation.

One very important advantage of the design is that it eliminates the necessity of providing one hundred per cent spare heating capacity except in the case of the installation of a single unit. The result is that there is a material saving in the initial investment. Another important feature is that the individual units can be cut in and out of use at fractional loads to better maintain constant oil temperature.

Besides the feature of extreme flexibility in the meeting of service requirements, the units have another distinct advantage which is their exceptional heating effectiveness. This effectiveness is due to the design of the pipe, which has an exterior surface of more than eight times the area of the interior cylindrical surface. Because of this special finned heating surface, the transfer of heat from the steam, which is contained inside of the pipe, to the oil flowing along the finned surface will be several times greater than with a bare pipe of equal strength.

Some of the other advantages of the oil heater are the absence of internal joints which might permit leakage between steam and oil, the elimination of strains from change in temperatures because of the free expansion of both shells and pipe, the ready accessibility of the entire heating surface for inspection and cleaning, and the light weight which permits easy handling and installation.

Viscosity Indicator

AN instrument which constantly indicates the viscosity of a moving fluid is available for commercial use. It consists of a cast iron body in the form of a conduit of flanged pipe section inserted in the

pipe line through which the viscous liquids are being pumped. At the top of the conduit is a closed chamber with an inlet orifice through which a small amount of the fluid from the main flow is admitted. This chamber is also provided with an overflow or relief valve for the maintenance of constant pressure within the chamber, irrespective of the fluctuations of temperature or pressure in the main conduit.

The fluid then passes from the constant pressure chamber through another orifice to the metering tube. The varying resistances to the flow of the fluid through the metering tube is indicated by static pressure reaction on a gage, the dial of the gage being calibrated in Saybolt seconds.

The sample of the fluid passed through the meter can be returned to the fuel oil tanks by gravity, or admitted to a float controlled receiver, from which it is returned to the suction side of the pump used.

Non-Poisonous Gas

THE city of Hamlin in Germany is now operating the first and only plant in the world for the removal of poison from gas. Whereas the line of American development has been to introduce some vile smelling compound into the process to serve as a warning of escaping gas, the German treatment removes the poisons. The plant is equipped to convert the carbon monoxide and steam into carbon dioxide and hydrogen with the aid of a catalyst so that the reaction may be carried out at about 400 C. The enriched gas is said to retain its physical and technical properties.

This undertaking, in the plan of which poison removal is only a part, anticipated far-reaching and comprehensive improvements in illuminating gas simultaneously with the production of non-poisonous gas for heating. Oxygen and tar mist, which clogs the burners, are completely removed while the amount of organic sulphur in the gas is reduced to 1 gr. in 100 cu.m. Finely divided sulphur, which may be obtained as a by-product, has been used in this country in processing soaps beneficial in treating some common skin diseases.

Naphthalene is also changed in this process. The burning of this compound is the main source of luminosity of the gas, an important factor where gas is used for lighting. Enough excess naphthalene is present, though, to furnish a supply for mothballs and still leave some. This is hydrogenated at the gas plant to give tetralin and other products which find a ready market. Profits from the numerous by-products greatly reduces costs, so that gas is furnished at a very low rate.

Nickel Plating

A new process for the electrodeposition of nickel will soon be placed upon the market. This new

process, it is stated, creates a nickel deposit of great brilliance irrespective of thickness of coatings, eliminating the subsequent polishing or color buffing, and simultaneously effects other economies and advantages in production, maintenance, operation, etc.

While plating as represented by the ordinary nickel bath with a brightening agent has been known and commercially used for years, its application has been rather limited to classes of work where only thin nickel deposits with varying brittleness and hardness of such a deposit is of no particular disadvantage. The new process is basically different in action, composition, and results obtained, from the commercial process now in use.

Some of the advantages claimed for quality and operating economies are: non-porous, close grained, elastic, ductile, adherent deposits which may be chrome plated without fear that the nickel deposit will lift or peel off. It also eliminates recleaning or reracking for chrome plating, provided a type of rack can be used which will not contaminate the various solutions by holding or absorbing the component solutions used. It is a highly efficient and suitable electrolyte with wide operating range.

The bright nickel process is suitable for still tank, semi-automatic or full automatic operation, and no major changes from conventional types of equipment are required.

Puncture Proof Tires

PUNCTURES and blowouts may be prevented by the use of this new product. This new substance is inserted into the tube through the valve aperture and is composed of exclusively natural products which are not deleterious to rubber. Floating freely within the tube it is thrown by centrifugal force against the periphery so that should the tire or tube be ripped or punctured, this material is immediately thrown by pressure into the opening. The result is that the puncture is immediately sealed by the substance. In the case of a blowout, the substance prevents rapid escape of the air and the car can be brought to a stop safely.

The substance, it is said, is not a conductor of heat and therefore will not transmit to the air in the tube the road heat absorbed by the tire tread. The weight and bulk of the substance are small. It can not choke up valves, undergoes no changes during the life of the tire, and is perfectly harmless to hands or clothes.

Organic Compounds in Power Generation

ORGANIC compounds, stable at high temperature, are proving their worth in power production. Bi-fluid boilers which have become important in enlarging the range of temperature over which heat engines operate have developed rapidly during the past few years. One unit which

has been in service almost a year reports greatly increased efficiency of heat utilization, although the cost is far below that of ordinary high efficiency boilers.

The simplest analysis of the Carnot cycle shows that higher temperatures make possible greater efficiency, but when a temperature of 750° F. is to be produced the steam pressure reaches 1600 to 1800 lb. per sq. in. The difficulties inherent in a simple steam system at such an elevated temperature are involved with the high cost of units to handle very high pressures and with the danger of burning out tubes containing steam alone when exposed to fire temperatures. By introducing into the superheater circuit a higher boiling, intermediate heat transfer agent (which can be handled at relatively low pressures), the cost of construction of the high-temperature heat absorber can be minimized, and, because the temperature of the heat agent can be held well below that of the fire, danger of burning out superheater tubes can be practically removed.

While mercury has been used in the superheater circuit to further heat the high pressure steam which is to go into the mains, it has two serious drawbacks in its poisonous vapor and excessive cost of six to eight times that of the organic compounds. It also has a film resistance great enough to seriously reduce its effectiveness in the flow of heat, for, as may be seen in a manometer tube, it does not even wet a surface like steel. These objections are overcome by using high-boiling organic compounds which are stable at boiler temperatures. The one used in this installation was biphenyl, which does not melt until it reaches 490° F., while its pressure at 720° is only 100 lb. per sq. in., so that no extra-heavy equipment, such as is ordinarily used, need be purchased.

Ball Race Locked to Conveyor Axle

A new ball bearing roller for use in either gravity or power-driven roller conveyors has just been developed. The principle involved is the locking of the inner ball race of the bearing to the axle of the conveyor.

The gear teeth on the axle and on the inside of the inner race are meshed, thus locking the inner race of the bearing to the axle and creating a smooth, even bed of rollers on which to convey heavy objects. In order to keep the axle from rotating on the conveyor frame it is held in position by standard cotter keys located at both ends, or by an upset by which it fits into a corresponding slot in the frame rail.

The labyrinth seals are fitted on the outer ends of the bearing so that dust, grit, and other foreign matter can not get into the bearings. On the inner side of the bearing is the grease retainer, of similar construction, fitting closely around the axle and thus forming a grease reservoir.

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF THE AUTHORS AND PUBLISHERS

Problems Connected with Stratosphere Ascension

By JEAN and JEANNETTE PICCARD

(From Industrial and Engineering Chemistry, February, 1935)

THE organization of a stratosphere flight is a problem for the engineer, especially the chemical engineer. The difficulties are not very different from those met daily in the laboratory and in the factory. Among these problems are air-conditioning, method of releasing ropes and ballasts, and gondola construction.

The problem of air-conditioning the gondola could be solved in two ways; by evaporating liquid air and releasing a corresponding amount of air into the near vacuum of the stratosphere. This method is very uneconomical, as it requires the release of 100 liters of air per minute to keep the concentration of carbon dioxide below 2 per cent. The more practical method is to absorb the carbon dioxide as soon as it is formed. To accomplish this, small mattresses of gauze were filled with potassium hydroxide to absorb this undesirable constituent. It was not certain that the potassium hydroxide would be 100 per cent effective under the circumstances, so a second set of bags containing flaked sodium hydroxide was installed. During the flight both sets operated very efficiently.

Water vapor was absorbed by installing a third set of bags containing anhydrous magnesium perchlorate. Magnesium perchlorate boasts two advantages over phosphorous pentoxide; it does not lose its porosity, and it does not leave a corrosive liquid when it is exhausted. In addition to the chemicals carried to absorb water vapor and carbon dioxide, granulated silica gel was employed to absorb organic chemicals of unknown origin which cause the difference between fresh and stale air. Silica gel was easily disposed of as ballast.

The nature of the delicate instruments in the gondola prevented launching the balloon in the ordinary way. The four ropes attached to mooring masts 18 feet high were cut simultaneously by 2-inch trinitrotoluene fuses, electrically fired from the interior of the gondola. The fuses attached to the ropes were surrounded by three small sandbags. This method of cutting was found to work very well.

Sixteen 80-pound sandbags and 700 pounds of fine lead shot were used for ballast. The sandbags were cut away

by electrically fired blasting caps which allowed the instantaneous release of any desired amount of ballast. The lead shot was disposed of through an airlock.

The gondola was made of a light, hard magnesium alloy, and was 213 cm. in diameter and weighed 100 kg. The wall thickness was 0.35 cm. An aluminum shell of equal dimensions weighs 50 kg. more.

Aluminum shells possess, however, several advantages over the lighter magnesium alloys: (1) lacquers hold much better to aluminum; (2) it is less corrosive; (3) the soft aluminum shell assumes the shape of highest resistance without loss of mechanical strength when subjected to its first pressure test.

Foolproof Devices Protect Coin Machines

By Harold B. Veith

PROTECTION against dishonest operators is secured in the Rowe cigarette vending machine by the incorporation of several novel devices installed in the operating unit.

The operating unit, installed in the right-hand side of the case, consists of three separate assemblies, a scavenger, a slug ejector, and a coin register.

The slug ejector protects the machine against such materials and metals as undersized disks, matches, hairpins, bent and distorted coins, etc. This assembly embodies a double coin raceway, one for nickels and one for dimes, each of which is only a few thousandths larger than the thickness and diameter of the respective coins. Hinged flaps in the raceways operating through the coin return plunger swing outward and deposit any obstacle in the coin return chutes, thus eliminating obstructions from the raceways. Certain sections of the coin raceways are chromium plated to minimize wear.

The slug ejector prevents spurious coins that are undersized from reaching the coin register. Tiny balances pivoted on pins in the coin path of the slug ejector slow down the proper sized coins and cause them to fall into the register. Spurious undersized coins travel over the scavenger race end and return through the return coin route. On the nickel side of the scavenger, undesirable materials, such as lead, are slowed down by friction created as the coin comes in contact with a flat spring, and thus are rejected.

Magnets make the final coin selection. They aid in the rejection of coins which may pass weight and dimensional requirements, but which possess improper chemical composition. The magnetic field solves the problem in distinguishing between real and spurious money.

A first magnetic member—a bar magnet—in acting on a coin, determines the steel or iron content of the coin. If attracted by the weak field force at this point, the coin comes in contact with the rounded end of the

bar magnet and is directed to the coin return chute. The original momentum of the true coins is sufficient to carry them beyond the field force attraction.

A second magnetic field created by the horseshoe type magnet (made of cobalt steel, and capable of attracting 27 lb. though weighing but 2 oz.) spots spurious coins by causing a retardation of their momenta in a degree varying with the magnetic conductivity of the metal or alloy submitted. The nickel alloy permits that coin such a speed that it exceeds that of most other slugs and coins and hence drops at a higher angle, clearing the raceway abutment and falling into the coin register. The other disks suffering a greater retardation of motion pass below the abutment and are deflected via the slug ejector raceway to the coin return chute.

To compensate for the weight variation influences of the dime and nickel it is necessary to use two magnets on the nickel chute and one on the dime.

Power Transmission by High Potential Direct Current

By HAROLD B. VEITH

By High Potential Direct Current

(From Power Plant Engineering, Feb. 1935)

A new constant-current, direct current transmission system of power was presented at the winter meeting of the American Institute of Electrical Engineers. The most important advantages claimed for the new system over the alternating current transmission system are: (1) No wattless power is transmitted; (2) A short circuit on a branch results in a reduction of power flow; (3) The circuit can be tapped at any point to furnish or take power; (4) Systems of like or unlike frequencies can be operated together to feed any other system of like or unlike frequencies; (5) Overhead systems suffer less disturbances caused by lightning; (6) The system cannot become out of phase with the system feeding it or with the system receiving power.

In a 3000 kw. constant current, direct current circuit, a group of condensers and reactors are connected to a 13,800 bus so that a constant-current alternating current is obtained. The current is tuned to 200 amp., and the voltage varies with the load. The alternating current is then rectified by six Phanotron tubes. If two-way transmission is desired, Thyratron tubes are used.

The high-voltage constant current is passed through constant-current smoothing reactors into an experimental transmission line 15,000 ft. long. Six Thyratron tubes then invert the direct-current into 60-cycle, three-phase alternating current of constant value. Another group of reactors and condensers then changes this constant current into constant-potential alternating voltage, the current output varying with the load.

A feature of such a network is that if it is tuned for a definite current and if it receives this current, constant potential results at the output terminals, and if it is supplied from a constant-

potential bus, constant current will be obtained at the terminals. Neglecting the losses in the reactors and condensers, the power factor on both sides of the network is equal, but opposite in value.

If a short circuit occurs on a 200 ampere constant-current line having a regulation of 10 per cent, a current of only 20 amperes will flow, and the voltage drops to a value sufficient to cause 20 amperes to flow through the short circuit. As soon as the short circuit is removed, normal current flows in the transmission system. It was found that half as many insulators will be required to insulate a system of this kind as for insulating an A. C. line of the same potential. Each insulator becomes a lightning arrestor as the dynamic current of the system is limited and the arc caused by a lightning flash extinguishes itself.

Traces from Tons

By DR. FLOYD J. METZGER

(From Ind. & Eng. Chem., January, 1935)

THERE are problems of chemical research and development involving the production in large quantities of products whose raw materials contain only traces of the products sought. Two outstanding examples of this are extraction of radium from pitchblende, which contains only one part per million of radium, and the recovery of bromine from sea water, which contains only 67 parts per million of bromine.

The following table gives the boiling points and composition of air. The figures given for the minor constituents are approximations.

Oxygen and nitrogen were the first to be used commercially. There are now two methods for the production of oxygen, electrolysis and liquefaction. All commercial oxygen is obtained by liquefaction and is 99.5 per cent pure. The demand for nitrogen came in connection with the various processes for nitrogen fixation. Nitrogen from air is readily produced 99.8 to 99.9 per cent pure.

The boiling point of argon is between that of oxygen and nitrogen. Therefore, argon may be diverted at a point where the oxygen vapor is richest in argon (5 to 7 per cent). This is rectified in a separate column to about 65 per cent argon, the remainder being oxygen and a little nitrogen. The oxygen is removed by combining with an exact proportion of hydrogen; and the nitrogen is removed by metallic calcium at elevated temperatures.

THE ATMOSPHERE COMPOSITION

	B. P., ° C.	*By Vol.*	*By Wt.*
NITROGEN	—195.8	78.03%	
OXYGEN	—183.0	20.99%	
ARGON	—185.8	0.94%	
HYDROGEN	—252.5	1 part in 10,000	
NEON	—246.3	1 part in 65,000	1 lb. in 44 tons
HELIUM	—269.0	1 part in 200,000	1 lb. in 72.5 tons
KRYPTON	—152.9	1 part in 1,000,000	1 lb. in 173 tons
XENON	107.1	1 part in 11,000,000	1 lb. in 1208 tons

For the extraction of helium and neon we must look to the coldest part of the equipment. Both these elements have very low boiling points and it is obvious that they will remain as gases in any air liquefaction process. These gases, whose composition is 40-50 per cent neon, 12-15 per cent helium and the remainder nitrogen, are drawn off at the top of the rectifying column and separated from each other by systematic absorption and re-evaporation from activated charcoal traps.

The recovery of krypton and xenon from the atmosphere is an extreme example of recovering "traces" of substances. Their boiling points lie considerably above those of any other atmospheric constituent, and hence they tend to accumulate in the warm end of the liquefaction system. These gases are also obtained in pure form by selective absorption in charcoal at low temperatures.

The extraction of helium from natural gas is an activity which originated during the war in an endeavor to secure a non-inflammable gas for lighter-than-air ships. Many sources of natural gas contain up to one per cent helium.

The first demand for the rarer gases came from incandescent lamp manufacturers about 20 years ago. They are chemically inert, but they possess unique and characteristic electrical properties. Argon has found its use as a substitute for nitrogen in incandescent lights, since argon filled bulbs operate at greater efficiencies than nitrogen filled lamps. It has recently been found that bulbs filled with krypton and xenon operate at an efficiency one-third greater than argon filled lamps. Neon and helium are employed in the lighting field to give the orange-red and the yellow or white colors, respectively. Other uses for the rare gases are lightning arrestors, high-tension testers, and detectors and luminous tubes for stroboscopes.

Tension Testing

By R. L. TEMPLIN

(From Metal Progress, February, 1935)

WITH the exception of the hardness test, the tension test is the most frequently made mechanical test upon metals. New methods were adopted last year by the A. S. T. M. (designated as specifications E8-33) which are believed to be a real advance over similar standard methods previously in vogue.

The development of satisfactory testing methods makes imperative the establishment of satisfactory and precise definitions of such terms as elastic limit, yield point, and proportional limit of elasticity.

Many of the difficulties encountered in tension tests, especially in thin sheet work, may be attributed to the type of grips used in testing. Specifications E8-33 present details for new standard types of grips suitable for threaded end specimens, shouldered end specimens, flat sheet, round wire, tubular products, and brittle materials.

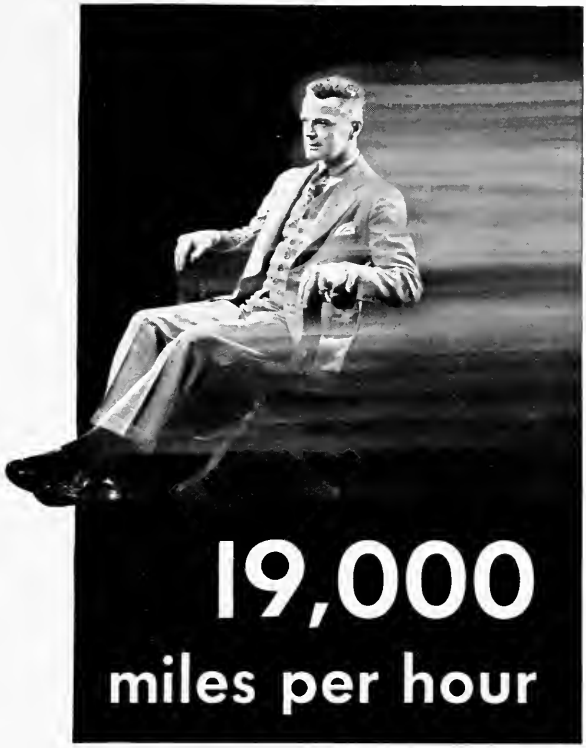
The proper preparation of test specimens relative to dimensional specifications to guard against the introduction of factors which will materially affect test results are discussed in the new specifications. Common practice conditions which are to be avoided are specifically cited.

The requirement governing the speed of testing is a conspicuous deficiency in the new specifications. Few engaged in testing work fail to appreciate speed variation effects in tensile properties. Though either the rate of deformation or the rate of loading may be used as a criterion in the elastic range of a material, only the rate of deformation will be a basis of defining the speed of testing in the plastic range of a substance. Few testing machines today have their testing speed controlled by the rate of deformation of the material tested. Therefore, it is desirable, if not mandatory, to omit speed requirements from the standard specifications applicable to present-day commercial testing.

A new section pertaining to the determination of the proportional limit, elastic limit, yield strength, yield point, and tensile strength deserves particular attention because it introduces the new term "yield strength." Yield strength is defined as "the stress at which a material exhibits a specified limiting permanent 'set.' The term has been evolved in response to an expressed need for a stress value corresponding to the yield point so familiar in the testing of wrought iron and mild steel."

The new standard "set method" determination of the yield strength of metals which do not have a yield point involves "the selection and adoption of an arbitrary constant value of 'set' for any given metal, a responsibility which seems to belong properly to committees established for formulation of proposed standards, or modifications of existing ones covering specific metals or metal products."

The selection and agreement upon a satisfactory "set" constant necessitates having a number of accurate and typical stress-strain diagrams from tensile tests of the specific metal under consideration.



By Long Distance telephone, a sales executive recently "covered" more than 153,000 miles in three business days. He spent a total of eight hours in talking with his agents in 194 cities—using Sequence Calling Service.

This service enables subscribers to place with the Long Distance operator any number of calls on which they wish to talk consecutively. Connections are completed rapidly with a minimum wait between calls.

Sequence Calling is just one of the many services developed to gear the telephone more and more closely to business needs.

Why not visit your folks tonight . . . by telephone? For a lot of pleasure at bargain rates, use station-to-station service after 8:30 P. M.

BELL TELEPHONE SYSTEM

Colonel Roosevelt, making a speech in Maine, asked if there was a Democrat in the house. An old, long-whiskered man rose in the rear of the hall and said, "I am a Democrat!"

"Why, my good man, are you a Democrat?" asked the Colonel.

"I've always been a Democrat, my father was a Democrat, and his father before him was a Democrat," said the old man.

"Oh," said Roosevelt, "if your father and grandfather had been horsethieves, you'd be a horsethief now."

The old man didn't blink an eyelash. "No," he said, "I'd be a Republican."

* * *

"I am out of politics for good," announced the political boss.

"Whose?" asked the green reporter.

* * *

"So you want to marry my daughter?"

"Yes, sir."

"Can you support a family?"

"Well—how many are there of you, sir?"

* * *

Keep hollering—
There's somebody
Somewhere that'll
Want what you've
Got sometime!

The owner of a trading post had advertised his need of a good horse, and he was soon visited by two Indians, each leading a fine steed. "There's little to choose between these two horses," said the trader, "So I'll do this. We will have a race, and the horse which comes in last is the one I'll buy."

The Indians were puzzled at such an absurd arrangement, and repaired to the tepee of the tribe sage for advice on the matter. After hearing their story, the wise man leaned over and whispered just two words to each man, and the two went away well satisfied.

What were the two words? Look at the end of this section if you don't know them.

* * *

Plenty of people in this world are much too tight. All you get out of them is gypped.

* * *

"Billy, aren't you going to say your prayers tonight?"

"Hell, no, ma. This is Sunday and I was to church. I'll take a chance."

* * *

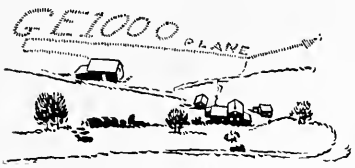
Editor: "This isn't poetry, my man, it's just an escape of gas."

Hopeful poet: "Oh, I see. Something wrong with the meter."

* * *

The two words are "Swap horses."

G-E *Campus News*



"GE-1000"

When, after a two-day search, a rescue plane finally located the lost transport plane which "mushed down" on a lonely Adirondack peak a couple of months ago, General Electric radio engineers rushed an emergency portable short-wave radio station into the mountain country to help in co-ordinating land and air rescue operations. The disabled ship was in the center of a wilderness, miles from the nearest means of communication. The radio expedition, however, managed to set up its equipment in a cabin at the end of a one-track automobile trail, only four miles from the scene of the mishap.

There, designated as station "GE-1000" at the request of the airline operators, the equipment was used as an emergency unit in the airline's radio system. The General Electric engineers co-operated in communicating with the planes that guided the rescue parties toward the stranded fliers. They also helped send back news of the rescue, directly to owners of short-wave receiving sets, and through a rebroadcast by WGY, the General Electric station at Schenectady, to other listeners.

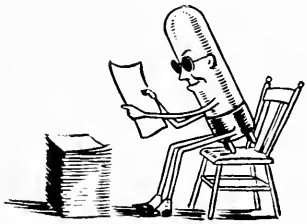
W. J. Purcell, chief engineer of WGY; W. R. David, U. of Kentucky, '19; E. H. Fritschel, Iowa State, '26; G. W. Fyler, Yale, '29; R. H. Williamson, Iowa State, '28; R. W. Orth, Minnesota, '30; G. M. Brown, Washington State, '29; and R. A. Lash, Ohio Northern, '29, comprised the General Electric radio expedition.

TURBINE BIOGRAPHY

A turbine can now write its own biography, with the aid of recording instruments recently developed in the General Electric general engineering laboratory.

These sensitive devices were developed for the supervision of large turbines from a point remote from the scene of operation. The instruments measure and record shaft eccentricity, bearing vibration, shell expansion, and interference of rubbing or rotating parts. They provide the operator with an indication and a permanent record, on paper, of mechanical performance throughout the starting period and subsequent running time.

C. D. Greentree, Alabama Poly, '28; A. V. Mershon, Pratt Institute, '13; and M. S. Mead, Case School of Applied Science, '23, all of the General Electric general engineering laboratory, worked on the instruments.



GLASSES FOR ELECTRIC EYES

Electric eyes are wearing colored glasses and doing a new job. As a result of strict NRA code requirements, the paper industry had to find a rigid means of classifying different qualities of paper. The Institute of Paper Chemistry found that as far as white book papers were involved, the percentage of light they reflected was an indication of their quality. The General Electric general engineering laboratory built the necessary device—an instrument which relies on the scrutiny of two phototubes in series to measure the coefficient of reflection. This is an exceedingly delicate task, as the matter of a small percentage of reflectivity determines the price and quality of a paper.

Here's where the glasses come in. To do certain jobs right, the electric eyes had to don different colored glass screens in the form of a filter and lens arrangement. It wasn't that they were getting old; they just needed a little assistance.

J. L. Michaelson, Northwest Missouri State Teachers College, '28, is G-E engineer in charge of building these instruments.

96-130FBI

GENERAL ELECTRIC

Knives of Flame

Oxy-Acetylene Machine Cutting and Flame Machining Lower the Cost of Fabrication.

By H. ULLMER*

LIKE CUTTING CHEESE—the oxy-acetylene cutting blowpipe demolishes a 52-ton cast iron rock crusher bowl.

Machines for guiding and moving the oxy-acetylene cutting blowpipe automatically are the most important of the recent developments in man's harnessing of flame for productive purposes. Like ribbons of fire, multiple flames of oxygen mixed with acetylene surround a jet of pure oxygen to cut steel, cast iron and other ferrous metals into intricate patterns—quickly and easily—with remarkable savings in costs over old methods.

New Methods of Production

Since 1905, oxy-acetylene cutting by hand has been widely used in demolition and maintenance work. During the last several years, the effectiveness of oxy-acetylene cutting as a means of production has been proved and tremendously multiplied by the development of machines for various repetitive cutting requirements. The operating fields of these machines range from the simple bevveling of steel plates to the cutting of intricate patterns. Most of the machines can cut vertically and horizontally. Some can be adjusted to cut circles without the use of patterns. Others cut bevels, gouge grooves, and shape complicated designs.

Shape Thousands of Identical Parts

The economical continuous or intermittent production of identical regular or irregular shapes from rolled or forged steel is an outstanding accomplishment of present day oxy-acetylene cutting machines. With remarkable ease they follow templets of the desired form for the pieces to be cut. So accurate are the results that for many purposes the cut pieces can be used without machining or further finishing. Only by looking close at the smooth sides of the cut can an experienced eye tell the difference from a mechanical cut.

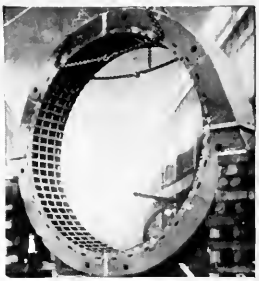
In a Wide Variety of Pieces

Some of the different pieces of equipment fabricated from oxy-acetylene shape-cut steel include: press frames of rolled steel requiring high strength and resistance to shock, gear blanks, cams in all types of intricate designs, forming dies which need little finishing before use, and flywheels often over a foot thick. In every case the shape-cut parts retain the great inherent strength and toughness of the rolled or forged steel from which they are made.

Costs Cut With Oxy-Acetylene Cutting

No great investment in machinery is needed for oxy-acetylene cutting.

ONE OR A MILLION—flame cut parts can be produced easily and cheaply by oxy-acetylene machine cutting. These dipper tooth blanks are alike as two peas in a pod. No expensive patterns or dies are required.



FLAME-CUT PARTS—are welded into assemblies like this yoke for a 25,000 KVA Water Wheel Generator.

Pattern cost is reduced to a minimum and the making and storage of expensive and intricate patterns is avoided. In most cases the machine cut shapes can be beveled easily by oxy-acetylene cutting and quickly made ready for assembly by welding, thus further reducing the cost of the finished equipment and making a more salable and a more serviceable product.

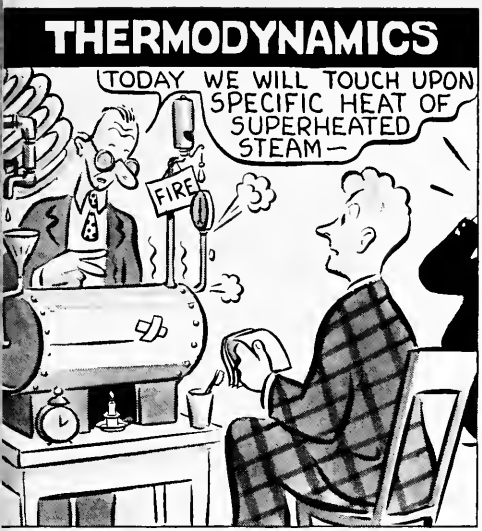
Machines Now Available

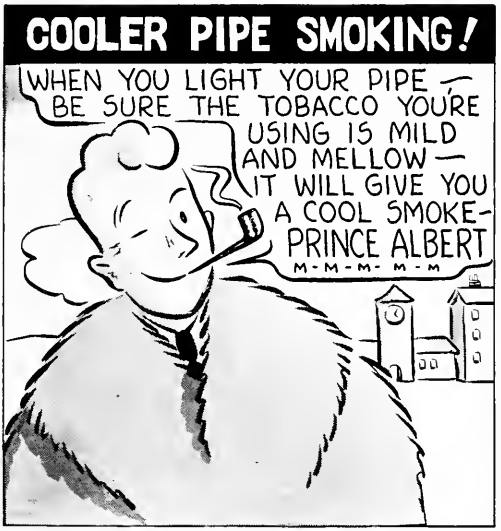
Machines of all sorts for various types of oxy-acetylene cutting and flame machining have been developed by The Linde Air Products Company, a Unit of Union Carbide and Carbon Corporation. Assistance and information as to how oxy-acetylene cutting can be economically fitted into your production operations can be obtained without obligation through Linde Sales Offices at Atlanta, Baltimore, Birmingham, Boston, Buffalo, Butte, Chicago, Cleveland, Dallas, Denver, Detroit, El Paso, Houston, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Phoenix, Pittsburgh, Portland, Ore., St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, and Tulsa. Everything for oxy-acetylene welding and cutting—including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through producing plants and warehouse stocks in all industrial centers.

With Engineering Cooperation

Users of oxy-acetylene welding and cutting, and other products and processes developed by Units of Union Carbide and Carbon Corporation benefit from a most unique coordination of scientific research with manufacturing, sales and service facilities. These combined resources of a vast organization assure a full measure of satisfactory performance.

*Chief Engineer, Service Division, The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.






TO BANISH TIREDNESS QUICKLY...
GET A LIFT WITH A CAMEL!
SPEAKING OF THE EXCITING SPORT with which his name has so long been associated, Ray Stevens says: "When the last heat has been run, it's mighty comforting to light up a Camel. That let-down feeling fades away. I enjoy the pleasure of smoking to the full, knowing that Camels never bother my nerves!" (Signed) RAYMOND F. STEVENS, North American Bob-Sled Champion
"I'M A CAMEL SMOKER. ... (Signed) JACK SHEA, Olympic Champion Speed Skater
"AS A MASTER BUILDER, I have learned that any real work that requires 'push' calls for Camels. They give me new energy when I'm feeling tired and listless." (Signed) FRAZIER PETERS
COLLEGE GIRL: ... (Signed) MARGUERITE OSMUN
LISTEN IN..
You'll like the Camel Caravan starring Walter O'Keefe, Annette Hanshaw, Glen Gray's Casa Loma Orchestra over coast-to-coast WABC-Columbia Network
TUESDAY 10:00 p.m. E.S.T. 9:00 p.m. C.S.T. 8:00 p.m. M.S.T. 7:00 p.m. P.S.T.
THURSDAY 9:00 p.m. E.S.T. 8:00 p.m. C.S.T. 9:30 p.m. M.S.T. 8:30 p.m. P.S.T.
MORE EXPENSIVE TOBACCOS IN CAMELS..
"Camels are made from finer, MORE EXPENSIVE TOBACCOS — Turkish and Domestic — than any other popular brand." (Signed) R. J. REYNOLDS TOBACCO COMPANY
CAMEL
TURKISH & DOMESTIC BLEND CIGARETTES
Camel's Costlier Tobaccos never get on your Nerves!
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MODERN ARCHITECTURE

THE
ARMOUR ENGINEER

MAY, 1935

Modern Trends In Architecture

By A. S. ALSCHULER, '99

JUST as in every other field of activity which is under stress at this moment, it is of interest to note the direction of the current in which we have moved in recent years, and to speculate on its future. For we have much to speculate about. Architecture is one of the oldest arts known to man. Its records are indelibly printed in the history of the growth of the human race and its currents and eddies, its stagnation and its movements are a subject of never ending interest. It should always be dynamic and should give expression to the life of the period in which it is cast. It should be ever changing and developing.

So it is but natural that these past twenty-five years, with their tremendously rapid and kaleidoscopic changes in every department of living, with the great advance in scientific knowledge, with the development of new materials in the building field, as well as in the Allied Arts, should call for and bring forth an urge to create an Art and Architecture expressive of these times and conditions.

To expect agreement on its forms or even its functions, to say nothing of its future development is as futile as to hope for agreement in any field of human thought. Its very life and growth will always develop with individual difference of expression which by accompanying friction frequently furnishes the spark of light for others to follow.

Editor's Note: Mr. Alschuler, a prominent Chicago architect, and member of the Armour Board of Trustees, has prepared this article for the ENGINEER.

Use of steel in carrying lines upwards to undreamed of heights with smaller piers developed by use of steel and concrete have created natural use for vertical lines, just as cantilever principles in concrete construction have created possibilities in horizontal lines, and each of these with unlimited variations made possible by the use of these newer materials have created new problems as well as the means for their solution by new methods, and thus a new style is created.

During this creative period, it is to be expected that it will pass through many stages during which it will be greatly strained in giving to each individual who seizes upon it an opportunity for what is called self-expression, but unfortunately when a building is given such expression, that expression when bad, cannot be easily obliterated.

It is, however, to be expected that any new movement must pass through such period of growth if it is to have any lasting merit. We must also realize that the past twenty-five years while a seemingly large period of our own lives are but infinitely small when considered in relation to the growth of an Architectural movement. We are still much too close to the situation to appraise accurately our recent progress. That there has been a definite departure from past forms is evident. How far it will go or what it may develop into or how lasting it will be, is at present only a matter of conjecture. The subject itself is so broad that we can only sketch in what seem to be some of the outstanding elements.

When we speak of "Modern Architecture," we must stop to realize that when the Romans developed their architecture, and applied thereto as surface decoration the post and lintel of the Greeks, this was also modern for them.

When the Lombards constructed their Temples for their newly acquired Christian religion in a fireproof manner and vaulted them in stone, they based their work on Roman models and finally developed an architecture, entirely different from the Roman, that spread through Europe changing in detail as the taste and artistic ability of localities varied. This also was modern.

And so the Gothic and Renaissance followed in succession, each developing not from the wanton idea of doing something different, but rather of improving upon the work of their predecessors, and in particular of solving in a better way the problems of their particular time. The early Christian Basilica could not be used to give the same expression as the lofty heights and pinnacles of the Gothic Cathedral, nor could the Gothic architecture be properly applied to a Florentine or Roman Palace, so likewise it is quite evident that none of these were suited for application to our needs of today. This, however, does not mean that all lessons of the past should be discarded

and only new forms employed. There is too great a wealth of beauty and dignity and a deep knowledge of harmony and proportion, of proper application of ornament and plain surfaces —in fact of the entire range of understanding of Architecture for it ever to be lost sight of. Without any desire to copy, it still has lessons of such deep value that it should always serve as a foundation for sound Architectural education. If the fundamentals and principles of this Architecture, which has survived the centuries, is really understood, this knowledge can then be used as a foundation on which to develop a new art on a safer, saner, sounder and more lasting basis.

A thorough training in the proportions of classic orders is such that one can detect in a drawing the variation of the thickness of a pencil line. That feeling of proportion, developed early, is simply one example of what help can be obtained by a study of the past. The Greeks were masters of proportion and the secret of their matchless art has ever been sought. The width, length and height of their buildings were always in marvelous relationship, and the feeling of that relationship, if once acquired, can be applied to any style that may ever be developed. To ignore these proportions or to cast them aside merely because they are old is likely to lead astray those who feel that a modern art must discard all precedent.

A building, such as the old Field Museum at Jackson Park, Chicago, is an example of classical architecture which should be a source of pleasure to behold as long as it stands.

The movement which we now consider as modern began early in this Century. Its inception is frequently traced to Louis H. Sullivan of Chicago, who started the departure from precedent and developed the slogan that "form must follow function." This is now generally recognized as sound doctrine, but buildings are frequently carried to extremes under the guise of functionalism. Sullivan's pupil, Frank Lloyd Wright, further developed this movement and the work of these two men has attracted world wide attention. Wright, while doing but a small amount of building himself, gave an undeniable impetus to others, some of whom blindly followed into newer fields.

Modern Architecture, however, is not limited to plain surfaces and soap box masses sometimes relieved with more or less bizarre ornament. Just as music and other arts are an expression of the times, so must we expect Architecture to pass through a temporary jazz period. This modern Architecture, with its lavish use of color, plays on the senses and emotions in a manner as subtle as music, but its lasting qualities will depend on its refinements, its balance, its harmony, just as in any music which has lasting quality.

Perhaps the one outstanding example of modern Architecture in Europe is the City Hall at Stockholm. One

can never forget the thrill received upon viewing for the first time the reflection of its golden cupolas in the water. This building has enough interest in it for a complete study by itself. It is original. Its underlying motifs may be recognized as coming from the Ducal Palace in Venice, just as some motif in music may have some previous foundation. But it is original and its charm is tremendously enhanced when in walking around its four sides and into its spacious court yard, one realizes a continuous change of detail, harmonious as a whole, but clearly indicating a degree of craftsmanship unlike our machine production and unhampered by limitation of cost or time in its development. The interior also displays a high degree of originality and interest. The building in general is restrained, beautifully detailed, harmonious, modern and lasting.

The Scandinavian countries, including Finland, have been leaders in the development of this new form of Architecture; Helsingfors has various interesting examples.

The early housing developments in Holland, Germany, Sweden and Austria have predominating horizontal lines, developed frequently with exterior of common brick sometimes combined with exposed concrete construction. This new style affords logical expression for this new material, and the simple type of modern design is still extensively used and has found reproduction in many of the recent housing developments in this country.

Individual housing was also developed abroad in which the predominant notes were extreme simplicity of surface combined with concentrated window openings. The plan as well as design was often forced in order to produce effects. In any event, they were new and frequently attractive.

Varying types of modern design were introduced into churches and often into public buildings in which entirely new forms were developed, some of which are extremely interesting. Whether they will last or not is still to be determined.

In France, under the leadership of Le Corbusier, this movement seemed to take a different trend, possibly expressive of difference of characteristics and temperament. There were few new homes of this type built in France and the type of expression was perhaps best indicated in the Paris Exposition of 1925. The general impression on reviewing photographs of this Exposition is one of restlessness, of many cut up surfaces with many curves and much ornament. Most of this was of a bizarre nature. It takes refinement and harmony to stand the test of time and it is questionable how much of the influence of that Exposition will endure.

England is quite conservative and has had little of a modern nature, relying mainly upon modification of the Georgian period. English architects seem too steeped in tradition to depart

greatly from it. The new Liverpool Cathedral might be called modern. There was a competition held for this building which was won by a young Architect who at that time had the courage to discard at least the detailed clothing of the past and develop an expression of his own. While distinctly Gothic in form, the detail is quite original and pleasing, and shows at least that it was not designed in the 15th Century.

Throughout Europe, as a whole, it is quite clear that the movement has taken hold and that it will be permanent. It is at least true that most new buildings are along modern lines and that the old classical copies are being abandoned. The general recognition of this fact is indicated by the name of International which is frequently applied to this style. This is unusual because for the first time in history one style has received international usage. Probably the closer union of all peoples due to almost instantaneous intercommunication has produced a greater similarity among all, and this similarity is finding expression in Architecture. The universal use of concrete construction is also a contributing factor. Undoubtedly, in time, distinctive expression will develop. We are still too close to the situation to form any judgment.

In this country, it is unnecessary to state it has taken a firm hold, and seems destined for continuous growth. It made itself felt first along the lines of the French influence in modernized store fronts with bizarre ornamentation. Much of this was bad and a great many of the shop fronts along Fifth Avenue and State Street have already been displaced. One result to be learned is that refinement above all is necessary.

Courtesy—Chicago Tribune

A great impetus was given to the movement as a consequence of the Tribune competition held in 1922. While the successful design was a mar-

velous adaptation of Gothic form to a modern problem, yet the design which received by far the greatest comment was the one which received second place—a striking design based on mass formation and submitted by Eliel Saarinen. Both in design and technique of rendering, it undoubtedly left a permanent impression which, from that time on, has been an influence in all office building Architecture at least. It seemed to furnish a logical expression along functional lines of what a skyscraper structure should be. To those who felt that this design should have been awarded first prize, it must be considered that from a purely practical consideration, had the width of the windows been measured, they would have been found entirely inadequate. The basis of this particular design was a solid mass with small openings. The successful design in this instance had almost double the amount of window surface and was particularly well handled at the corners.

Examples of all kinds in this country are too numerous to mention. Residential architecture as exhibited at our recent exposition was good in spots, but seemingly extreme in many instances. The attempt to design in units for mass production, while clever, left much to be desired in the way of comfort. Houses should have the feeling of roominess. Rigid congestion to provide economy has little appeal and will be accepted only if substantial savings are effected. The desire to express the owner's individuality in his home is a major element which runs contrary to mass production. There is no doubt whatever that attempts to develop mass production will continue.

In commercial Architecture, particularly in store fronts, the new forms have lent themselves to the use of many new materials which the rigidity of older forms did not permit, and many attractive designs of great variety have resulted. Factory buildings which are largely utilitarian, with little freedom for design, do nevertheless present a certain degree of latitude for original treatment.

This art has given us a new degree of freedom to use imagination and skill to create buildings of today without the restraint of the past. The abuse of this freedom must of course be expected, especially through the transition period.

This art has combined in an entirely new way the use of color, lighting, interior decoration and furnishings that require a greater skill in handling, as well as giving to the designer a greater opportunity than ever before. With the rich background of the past as a guide, with growing independence of thought, with an intelligent use of new materials as they develop, there is visible an enormous field for growth in the future. The horizon has been greatly expanded and no one can venture to forecast its limits.

Graduate Study In Engineering

By DEAN M. L. ENGER

FOR most engineering students, the usual four year course is the natural terminal of formal education, but it is becoming evident that graduate study is necessary for those who are to be engaged in research or design.

Courtesy—Illinois Technograph

Dean Enger

Graduate study would now be profitable for ten or fifteen per cent of graduates from the four year course. Most of these would probably be satisfied with one year of graduate study, but probably one-fifth should go on to the doctorate.

Many years ago the engineering curriculum had a relatively small technical content. There were few technical text-books, and laboratories developed slowly. With the progress of engineering science, new technical courses were added from time to time, and some of the existing technical courses were lengthened to include new material. It was then a simple matter to make room for the additions by reducing the non-technical content of the curriculum. When the non-technical courses had reached the irreducible minimum, curricula were multiplied and options were added. The enrichment of technical courses by the addition of new material goes on steadily, but a corresponding subtraction of material is seldom made. As a result many of the technical courses are

Editor's Note: M. L. Enger, Dean of the College of Engineering and Director of the Engineering Experiment Station at the University of Illinois, has prepared this second in a series of articles by Deans of Mid-Western Engineering Schools.

crowded beyond reason. The capacity of the student to absorb knowledge has not increased.

Many instructors have thought it necessary to put pressure on the student by the assignment of many problems and reports, due at frequent intervals. The method has proved effective in promoting intense activity on the part of the student and, possibly, in developing the habit of industry. Instructors who do not favor the pressure method have been compelled to adopt it in order to obtain a fair share of the student's attention. The objection to the method is that while the student delivers a large mass of material which can be measured objectively, the knowledge gained is superficial. Four years of minutely directed activity is poor preparation for self-education which should follow graduation.

The difficulty in improving the situation, which is recognized as unsatisfactory by most engineering educators, is that the student needs a large fund of general technical information for a back ground. It is probable, however, that the importance of much of the informational material is overrated. For a child, the acquisition of information is an important part of education. The merit badge study of the Boy Scouts is highly educational at that age level. The purely informational material which properly can be included in college courses should diminish in the later years in college.

Graduate instruction should be planned to supplement the undergraduate work. Thoroughness can be inculcated by concentrating the student's attention on a limited field. Independent thinking should be demanded. In graduate study worthy of the name, the student should not be driven to accomplish a large number of small tasks under close supervision. Instead, the student should be subjected to a minimum of specific direction. The professor should be an advisor and a critic, but the responsibility for performance belongs to the student. Only in this way can the student develop the capacity for self-education. The graduate student fortunate enough to have his work under high-grade professors is often discouraged and unhappy at the end of the first month. He has not adjusted himself to the changed regime and he is appalled by the superficiality of his knowledge.

It must not be thought that the information gained by limiting the student to a small field is the object sought. Very few students can predict their interests even ten years in the future. But the mental habits developed by intensive work in a limited field are of general application. Successful men who specialized in fields of graduate study remote from their present interests are nearly unanimous in the belief that their years of graduate study were well spent.

The scholastic requirements in a graduate school are much higher than in the undergraduate colleges. Only superior students should plan for graduate study, because only they can do

so profitably. It is unfortunate that so few students of the scholarly type plan to take graduate work. We know the sacrifices often made to complete the undergraduate requirements, but it is inconceivable that so large a proportion should find exactly four years as the limit. Many colleges offer scholarships which cover the expense in whole or in part. The demand for scholarships far exceeds the number which are offered.

The student intending to register in graduate work should make some modifications in his undergraduate curriculum. A reading knowledge of French and German is usually a prerequisite for entrance to the second year of graduate work, but is sometimes not required for the first year. The language requirement makes trouble for many graduate students, because if they have not studied languages, it is necessary to devote valuable time to making up the deficiency. It is strongly recommended that language courses be taken as early as possible by students who intend to take graduate work.

Much of the graduate work in engineering requires a better knowledge of mathematics than is necessary in undergraduate work. A good working knowledge of differential equations is very desirable in many graduate courses. Graduates from European universities almost invariably have a more comprehensive training in mathematics than is usual in the United States, which is probably the principal reason for the disproportionately large number of graduates from foreign universities holding the higher technical positions in this country.

The Steam Jet In Refrigeration

By H. L. NACHMAN, '02

IN the vapor compression refrigerating cycle, any substance which may be vaporized by absorbing heat at low temperature and pressure, and condensed by the abstraction of heat at higher temperature and pressure may be used as the refrigerant. There are, of course, many other qualities to be considered such as inflammability, toxicity, pressure limits, cost, etc., which make one refrigerant more desirable than another.

Where low temperatures are not required water possesses many desirable qualities for this purpose. It is for this reason that considerable attention has been given to the steam jet refrigerating machine by engineers interested in air conditioning. In this work there is required a supply of cold water ranging in temperature from about 35° F. to 60° F. This water is to be used either in air washers or in cooling coils.

In using water as a refrigerant at these temperatures, the volume of water vapor which must be compressed becomes extremely large even in a machine of moderate capacity. A reciprocating compressor would be entirely impractical. To illustrate the point: a modest six or seven-room house would require a refrigerating machine of say five tons capacity. If water at 40° F. were to be provided for this purpose about one pound of water per minute would have to be evaporated and the water vapor resulting would have a volume of 2,445 cubic feet. A compressor having a two-foot diameter, four-foot stroke and running at 200 r.p.m. will have the required displacement. This is obviously impractical.

In 1910 Le Blanc, a French engineer, installed the first commercial refrigerating machine in which a steam jet was used, in a mine at Bethune, France. Two or three more were installed by the Westinghouse company in this country. It was not until about 1928, when air conditioning had be-

Editor's Note: H. L. Nachman, Professor of Thermodynamics at Armour Institute, has incorporated his original investigations in this article.

come a promising field for the engineers that this type of refrigerating machine received serious consideration.

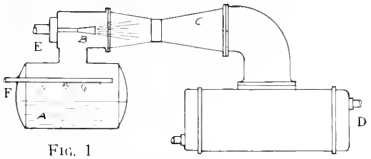
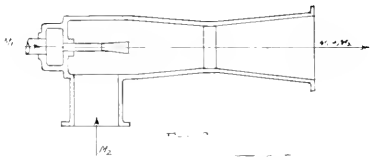


Fig. 1

The essential elements of the machine are shown diagramatically in Fig. 1. Here A is the evaporator or flash-chamber in which a very low absolute pressure ranging from .1 to .25 lb. per sq. in. is to be maintained. The corresponding boiling points, at which the water in this chamber is vaporized, are 35° F. to 60° F. The water to be cooled enters the evaporator through pipe F in the form of a spray at a higher temperature. A portion flashes into steam and the heat required is furnished by the water itself, thus cooling it to the temperature corresponding to the pressure in the evaporator.

At B is the steam nozzle in which steam entering through pipe E from the boiler is expanded and attains a very high velocity of about 4,000 ft. per second. The jet issuing from nozzle entrains the vapor from the evaporator and compresses it to a higher pressure in the diffuser C. To compress this vapor to atmospheric pressure and simply discharge it into the atmosphere would require an amount of steam which is entirely prohibitive. Therefore a condenser D is used in which the steam and vapor is condensed. The pressure maintained in this condenser ranges from about 1″ to 4″ hg. A small steam jet ejector, not shown, removes the incondensable gases from the condenser.

An important factor in the economy of this machine is, of course, the amount of steam required by the jet to remove and compress one lb. of water vapor. In Figure 2, M_1 represents pounds of steam from boiler at pressure p_1 per unit of time, M_2 pounds of water vapor from evaporator per unit of time, and p_3 pressure in the condenser. The energy equation for steady flow is applicable to this case: that is, the energy flowing into this device is equated to the energy flowing from it per unit of time, then



$$(1)\quad M_1 h_1 + M_2 H_2 = (M_1 + M_2)\left(h_3 + \frac{w_3^2}{2\,gJ}\right)$$

where h_1 = total heat (enthalpy) of steam entering nozzle
h_2 = total heat of water vapor coming from evaporator
h_3 = total heat of mixture leaving diffuser
w_3 = velocity of mixture leaving diffuser in ft./sec.
J = mechanical equivalent of heat = 778 ft. lbs.

The quantity $\frac{w_3^2}{2\,g}$ is the kinetic

energy of the mixture leaving the diffuser. Unless the discharge velocity is high this quantity will be small in comparison with the enthalpies. Assuming it negligible and solving equation (1) for M_2 we obtain

$$(2) \qquad M_2 = M_1 \frac{h_1 - h_3}{h_3 - h_2}$$

$$\text{or} \quad \frac{M_2}{M_1} = \frac{h_1 - h_3}{h_3 - h_2}$$

If in this equation M_1 is set equal to one, this is the ratio of number of lbs. of steam required by the jet per lb. of water vapor removed from the evaporator. The quantities h_1 and h_2 are readily obtained from the steam tables or the Mollier chart. However, in order to obtain h_3, assumptions as to the efficiency of the steam jet as a compressor must be made. By means of a problem and with the help of the Mollier chart as in Fig. 3 this may be illustrated. Assume steam pressure 100#/sq. in. absolute, pressure in evaporator .5" hg. absolute and pressure in condenser 3" hg. absolute.

The ideal adiabatic expansion of the steam is represented by the line A B and $h_1 - h_e$ equals 1186.6 — 830 or 356.6 B.t.u., which represents the kinetic energy of the jet, per lb. of steam, as it leaves the nozzle. The adiabatic compression to condenser pressure along B K requires 914 — 830 = 84 B.t.u., thus leaving 356.6 — 84 = 272.6 B.t.u. to do the work of compression on the water vapor from the evaporator.

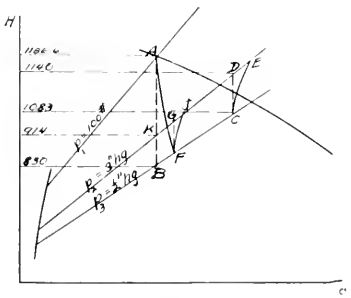


Fig. 3

To compress one lb. of water vapor from ½" hg. to 3" hg. absolute pressure requires 1140 — 1033 = 107 B.t.u. Thus for this ideal frictionless case, with the further assumption that the residual kinetic energy in the diffuser is zero, one lb. of steam should be able to compress 272.6 ÷ 107 = 2.55 lbs. of water vapor from evaporator pressure to condenser pressure.

Now let us see what the real conditions are. The expansion in the nozzle is not frictionless. The loss due to friction may be taken at 10 per cent of the available adiabatic heat drop. The expansion in nozzle is along the line A F and the available kinetic energy is .90 × 356.6 = 321 B.t.u. The efficiency of this device as a compressor is probably less than 50 per cent. Assuming it at this figure, the energy required to compress the pound of steam to condenser pressure requires 84 ÷ .50 or 168 B.t.u. available for doing the work of compression on the vapor from evaporator. The energy required to compress one lb. of this vapor is 107 ÷ .50 or 214

B.t.u. If now the kinetic energy of the vapor leaving the diffuser be subtracted from the available energy, the equation for M_2 per lb. of steam is

$$M_2 = 153 - (1 + M_2)\frac{W_3^2}{2g}$$

W_3 is the velocity of steam at discharge from the diffuser. This will be not less than 500 ft. per second so that

$$M_2 = 153 - (1 + M_2)\frac{250{,}000}{778 \times 64.3}$$

$$\text{or} \quad M_2 = \frac{153 - (1 + M_2)\frac{5}{214}}{214}$$

$$M_2 = .675\#$$

Since one ton of refrigeration is equivalent to the removal of 12000 B.t.u. per hour, it will require an evaporation of $\frac{12000}{r_e}$ lb. of water in the evaporator per ton of refrigeration, where r_e is the latent heat of water vapor at evaporator pressure. For the above condition this is, $\frac{12000}{1058} = 11.34$ lbs. The steam required for the jet is therefore, $\frac{11.34}{.568} = 20\#$ per hour per ton of refrigerating capacity.

The entire thermodynamic process is represented on the total heat (H), entropy (s) plane in Fig. (3). AF represents the expansion of the steam in the nozzle down to evaporator pressure, and FJ the recompression back to condenser pressure. Assuming the vapor in evaporator to have quality .95, CF represents the compression of the water vapor to condenser pressure. In the diffuser where these vapors mix, there will be a transfer of heat from one to the other until the two state points J and D meet at some point such as E located on the constant pressure line P_3.

The steam rate of 20# per hour per ton of refrigeration is probably somewhat better than is obtained at the present time with this type of refrigerating machine. This rate compares favorably with power requirements of other types of refrigerating machines. There are undoubtedly possibilities of improving the efficiency of the steam jet as a compressor. Some experimental work along this line has been done by F. R. B. Watson, who investigated the proper position of the nozzle relative to the diffuser. He used a steam jet compressor with a sliding diffuser so that the distance from nozzle outlet to diffuser throat entrance could be varied. These experiments, while operating under conditions different from those prevailing in refrigerating machinery, showed that the position of the nozzle discharge relative to the diffuser throat is important.

The steam jet refrigerating machine is not applicable in all situations. Its special field is where moderately low temperatures are required and where a supply of condensing water is available at low cost. This is important, as from 250 to 300 gallons per hour are required per ton of refrigeration. Its great simplicity and lack of mov-

ing parts subject to wear recommend this type of refrigerating machine where it can be used. Control is simple; by means of a number of jet compressors on one evaporator unit either manual or automatic control may be obtained with varying load.

Figure 4 shows the installation of a 600-ton machine in the plant of the Anheuser-Busch Company. It serves to remove the heat of fermentation from the yeast vats. At full load it has a capacity of cooling 720 gallons of water per minute from 85° to 65° F. The evaporator is divided into four compartments, each served by a steam jet compressor which has a maximum capacity of 180 tons of refrigeration. Thus, by varying the number of jets in operation, capacities of 180 tons, 360 tons, 540 tons and 720 tons may be obtained. Two of the compressors are manually controlled, the other two are automatically controlled by thermostats.

Courtesy—Foster-Wheeler Corporation

FIG. 4. *Steam jet vacuum refrigeration unit installed at the Anheuser-Busch brewery in St. Louis. Heavily insulated flash chamber is at the left and surface condenser at the right.*

Recent Armour Graduates In the Professional Field

Edited by G. FREUND, '36

FEELING that part of the education of the technical student at Armour should be a conscious realization of the practical value of subjects now being taught him, the staff of the *Engineer* sent out a form letter to about fifty of last year's graduates in the various departments, and asked if they would not send in a written reply to the question contained in the letter. This question was: "What subject, group of subjects, or field of knowledge has been of most value to you in your professional work?"

The number of answers received, as a result, was rather disappointing when compared with the number expected. However, we did get in about ten letters from the alumni, some of which were quite long and complete, and shed considerable light on the subject.

It was the original intention of the writer to analyze these replies in a statistical manner, and thereby obtain a fair analysis of the relative value of subjects taught here at the school. This was not possible for two reasons, the first being that the paucity of replies deprived statistical analysis of

any worthwhile meaning, and second that only about half of the answers were on the requested topic, being instead devoted to a discussion of the value of A. I. T. subjects in getting and keeping a job, and not the other matter of the actual application of that knowledge in making money, to put it bluntly. In other words a good percentage of the letters were on the subject of seeming valuable, rather than necessarily being so.

Because of this diversity of replies, the writer feels that a brief extract from the letters will be of more interest than any summary could be.

As an example of the multiplicity of possible types of replies, the letter written to us by Mr. Kreisman, chairman of the 1934 Alumni Association of Mechanical Engineers is of especial interest. Mr. Kreisman, who is now teaching at Schurz among the regular nightschool courses there, states that the course in Air Conditioning is far and away the most valuable from his point of view, inasmuch as that is the subject which he now teaches. This was admittedly, he stated, a very special situation, and not at all the sort of thing that the average graduate will come up against.

This is well brought out in the fact that a goodly portion of the letters concerned themselves with an attempt to express the value of the entire course given at the Institute, in terms of the spirit in which it was taught and received. Some of these generalizations were so interesting that we set them down here:

Mr. Ray Fleissner: "One can hardly follow through four years of any college course and not obtain an inkling of what might be termed: 'How to solve any problem.' This is even more true regarding an engineering training."

Mr. Robert Nelson: "The best help I have received from my studies at Armour is the fact that I have formed the habit of solving any problem presented, by reduction to fundamentals learned from the good old text books, and also the habit of knowing how to concentrate enough to realize how simple and fundamental most situations and problems are."

Mr. Hensel: "My professional work requires a knowledge of how to use the tools of every single craft, with a monkey wrench to boot. The duties are varied from day to day with the result that only an Armourite or a Philadelphia lawyer could be efficient in their performance."

It was easy to discern in almost every one of the letters a most admirable tendency to crystallize the bitter experiences and disappointment of the first months of exposure to a cruel world, in a few concentrated words of advice, in the hope that such knowledge would enable future graduates to avoid the pitfalls which are liable to beset the paths of all young engineers.

Mr. Harold Davidson: "Learn as much as you can in every subject you

take. It is there for a good reason, but don't think that it will help you get a job, because it will not. It will help you keep it when or if you get one."

Mr. Fleissner: "By the time one has advanced to a point where the problems one is required to solve are of the truly engineering type, requiring knowledge parallel to its importance and severity, the solution is generally found to be dependent upon continuity of attack, and the recollection of definite ideas accumulated in the study of the particular subject."

Mr. Hensel: "The Armour graduate is prepared for a variety of positions in industry. When an occupation is secured the story changes slightly. The student now specializes in one or possibly a few channels. He is still a student, nevertheless, and must readjust his life accordingly."

Mr. Kreisman: "The 'guts' required to be an engineering student, and given to him at Armour, is of the greatest importance in securing and keeping a job."

The author is not going to attempt to draw any conclusions from these observations of the alumni, by reason of his total lack of experience, and also since these same observations do not readily lend themselves, as stated before, to generalizations which are of any evident value. We cannot refrain, however, from noticing the high praise which eminates from all these sources concerning the completeness of Armour's course. None of the answers of people from whom we heard had anything to say in the way of a regret that such and such a particular subject should have been taught at the Institute and wasn't. We think that this is a fair proof that the industrious student at Armour emerges with a training unexcelled from a basis of the imparting of all necessary fundamentals to its graduates.

Certainly this is a tribute to the wisdom and foresight of those men who have helped to evolute the courses at the Institute that they might more adequately fulfill the myriad and ever-changing demands of industry.

Some Characteristics of Steel

By A. M. LANE, '36

IN the foregoing discussion[1] references have been made to the crystalline structures of steels, and the term *grain* has been used synonymously with the term *crystal*. That the structure of steel is generally crystalline is an hypothesis of long standing, and the hypothesis was substantiated through investigations inaugurated by Heyn, in 1898, and subsequently advanced by Hull,[2] in 1917, and a number of other X-Ray technicians. These investigations have established that in the case of normally cooled iron (or steel) the structure of the grains (crystals) simulates that of a body made up of most closely packed cubes with one atom located at each corner, and one at the center of each cube. This regular arrangement of the atoms (or molecules of monatomic iron) is confined to a repeating pattern identified as *body-centered cubic space lattice*, and the state of aggregation persists throughout the structure except at the grain boundaries, where the atoms have a disorganized arrangement and effect a thin film termed *amorphous cement*. The amorphous matter serves to bind the mass together and, on the whole, to resist disruption of the crystals under the influence of stress. It is stronger under conditions of loading than are the crystals, which have been shown by Rosenhain [3] to have definite planes of weakness, less in the influence per unit area of the forming atoms than others, which may act either as *cleavage planes* or *slip planes*. The term *slip planes* is usually reserved for application to crystals of reasonable ductility, while the term *cleavage planes* is associated with more brittle crystals.

Alterations of structural characteristics under the affection of time rate of cooling are bound up with crystal formation in steel. Crystals, initially

1. *See* ARMOUR ENGINEER, *March, 1935.*
2. *A new method of X-ray Crystal Analysis. Journal of the American Chemical Society, Vol. 41, No. 2, Dec. '17*
3. *An introduction to the story of Physical Metallurgy.—W. Rosenhain, D. Van Nostrand Co., New York, N. Y.*

minute at the instant of formation, may grow rapidly or slowly, dependent upon conditions of nuclei concentration and temperature state. Normally, crystal growth of decomposing austenite is a slow process. Slow cooling is, of course, a relative term. With that thought in mind, slow cooling as used heretofore was indicated as of a nature consistent with free grain growth. Such cooling would be accomplished by gradual reduction in temperature of the heat source or furnace. In the ensuing few paragraphs a new type of slow cooling will be alluded to as means for securing grain-sizes much smaller than those attendant upon modifying furnace temperatures. These accelerated slow coolings may be secured by removing the solid steel and allowing the heat to escape to the air; or, again, the heat supply may be discontinued and the steel allowed to cool with the furnace.

Some conception of the bearing that crystalline structures have upon the physical properties of metals is essential to an understanding of the relative importance of grain-size. It is well recognized that the ductility of metals (their power for undergoing plastic deformation without rupture) resides in their crystalline character. Plastic deformation takes place within the crystals of metals by a block movement or process of slip, occurring on slip planes, whereby the crystals accommodate themselves to the new shapes imposed upon them by the deformation of the mass. The deformation in a crystal can occur more easily in some directions than it can in others; and, since the individual crystals

FIG. 2

Block movement along slip plane in 0.15 Carbon Steel x 100. Steel section of a 4" rolled plate used in pressure vessels which failed, due to frequent over-heating, after 20 years of service.

in a piece of metal have different orientations, it follows that deformation must occur in each individual grain in a manner peculiar to that grain. The manner of deformation is influenced by the orientation of the crystal, the direction of the applied stress, and the obstruction of adjacent grains. This latter influence is apparent from consideration of the facts that the slip plane of a single crystal must necessarily terminate at the grain boundary, and that deformation of a single crystal may frequently sponsor rotation of an adjacent crystal not favorably oriented for free continuation of plastic flow. The property of elasticity is de-

rived from interatomic forces which are of two kinds. The atoms of the metal have a force of attraction for each other which varies inversely as some power of their distances apart; and they, being in a state of constant vibration, are subject to vibratory forces, a function of absolute temperature. In the fluid state, the amplitudes of these vibrations are too great to permit of the atoms assuming any fixed arrangement relative to each other. With the diminution of vibratory force that is consequent upon cooling to the solid state, there occurs a corresponding shrinkage of the amplitude of vibration; and the attractive forces are able to draw the atoms into closer group association. Contact between atoms is not attained, since the amplitude of vibration, acting with repelling force, is still in excess of the attractive forces. The positions taken up by the atoms are essentially positions of equilibrium state for all of the forces. The distance of separation of the nuclei of any two atoms must be at least slightly greater than twice the amplitude of vibration, and it is definitely known to be several times the diameter of the atoms themselves; therefore a slight displacement of the atoms is possible without a resultant breaking of atomic bonds. Application to any single crystal of an external force will disturb the equilibrium; but, so long as that force does not exceed certain maximum limits, atomic bonds will not be broken; and removal of the straining force will permit the atoms to resume their original positions. Any stress that is imposed upon a steel member is distributed over the crystals generated, as already explained, out of atomic group association, the distribution being effected through the medium of the stronger amorphous cement or network. The deformation must, generally, be in the direction of the line of action of the stress. However, distortions introduced by interferences with each other do not allow of perfect and regular crystal formation. Rather, an haphazard arrangement results, and those crystals whose planes of slip lie at some angle with the line of action of the stress are affected toward deformation only by a component of the then resolved stress. The forces of cohesion between atoms of a crystal decrease directly with increase in size of the crystal, and slip is, obviously, more easily produced in large crystals than it is in the smaller ones. In a later paragraph involving hardening theory, it will be shown that the products of rejection associated with austenite decomposition are dependent upon the same factors for their distribution (wholly as fine network surrounding grains or coalesced masses) as are crystals for their sizes. Account will be taken of the relation between network and grain size. It will be shown that the action of plastic flow generates amorphous products that serve as key particles which tend to prevent easy slip along the planes of weakness, and a relationship between

grain-size and keying values will be established. A summation of these characteristics associated with plastic deformation in its action and with resistance to that action, when coupled with the knowledge that failure in metals results from excessive deformation, leads to the conclusion that the relative importance of grain-size is indeed great. It should not, however, be inferred that fine grain-size is necessarily the criterion for quality steel. In a very general way, steels of fairly coarse grain-size are more desirable for case hardening applications. The machinability of coarse grain steel is, likewise, generally better than that of the fine grain steels. However, fine grain steels offer distinct advantages in being less subject to embrittlement by cold work, in enduring higher impact and tensile stresses, in freedom from forging defects and quenching cracks.

In a recent paper presented by Davenport and Bain [3] as part of the Grain-Size Symposium of the American Society for Metals, the influence of grain-size alone upon the impact strength of an 0.85 per cent carbon steel was graphically reported as shown in Figure 3. The values shown are average values obtained from a series of unnotched specimens originally fully martensitic throughout and then tempered to exactly 50 Rockwell C over the entire range of grain-sizes.

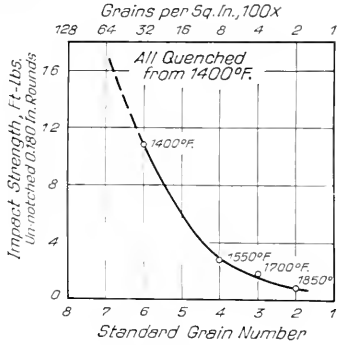


FIG. 3.

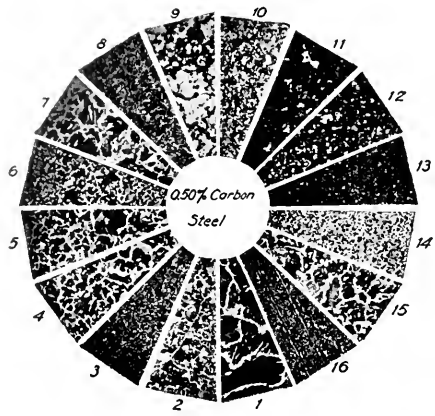
Courtesy—American Society for Metals

All of the 0.180 inch rounds were quenched from 1400 degrees F. although the coarsened grain was secured by preheating at the higher temperatures indicated on the graph. Similar tests conducted by certain other investigators on tensile specimens show correspondingly favorable results for fine grain steels.

To the designing engineer the modifications of grain-size in steels that are most important are those attained by reheating the metal after work has been done on it. Figure 4 is a composite arrangement of photomicrographs made by Sauveur.[4] It depicts various structures resulting from different heat treatments of a steel and shows, somewhat, the wide diversification of grain-sizes that may be pro-

3. *General relations between grain-size and hardenability and the normality of Steels—E. S. Davenport and E. C. Bain. Transactions of the A.S.M., Dec. 1934*

4. *Reprinted from the Metallography and Heat Treatment of Iron and Steel with the kind permission of Professor Albert Sauveur of Harvard University.*



Courtesy—General Electric Company
FIG. 4
Various Structures of Steel Containing 0.50 Per Cent Carbon; Magnified About 30 Diameters
Legenda for FIG. 4

1. Cast steel.
2. Cast Steel improperly annealed.
3. Cast steel properly annealed.
4. ½-in. round rolled steel cooled from 2010 deg. F. in the furnace.
5. ½-in. round rolled steel cooled from 1835 deg. F. in the furnace.
6. ½-in. round rolled steel cooled from 1650 deg. F. in the furnace.
7. ½-in. round rolled steel soaked 2 hours at 1650 deg. F. and cooled in the furnace.
8. ½-in. round rolled steel cooled from 1650 deg. F. in the air.
9. ½-in. round rolled steel cooled from 1835 deg. F. in water.
10. ½-in. round rolled steel cooled from 1650 deg. F. in water.
11. ½-in. round rolled steel cooled from 1650 deg. F. in oil.
12. ½-in. round rolled steel quenched in water while passing through critical range.
13. ½-in. round rolled steel quenched in oil from 1565 deg. F.; reheated to 1110 deg. F. and quenched in oil.
14. ½-in. round steel finished at proper temperature.
15. Large forging showing finishing at too high a temperature.
16. Cold worked.

duced by modifications of heat treatment. One group of such rectifications are classified as annealing methods and are usually carried out with the following aims: (1) To soften the steel to meet certain physical requirements or to get it into condition for easy machinability. (2) To relieve internal stresses set up by rolling, forging, or drawing. (3) To destroy coarseness of grain and re-establish more desirable combinations of strength, elasticity and ductility. Annealing is usually carried out on hot worked steel parts owing to the fact that their grain structures frequently lack homogeneity and are, due to high finishing temperatures, comparatively coarse. Steels that are cold drawn, such as wire, tubes, and sheets, require annealing to restore reasonable ductility. Machining of parts sets up internal and surface strains, and these must be relieved by annealing prior to heat treatment.

Certain of the annealing processes employed to relieve stresses alone, such as those employed in annealing cold drawn wires, tubes, and sheets, are carried out below the lower critical range of temperatures. Another process, more properly called spheroidizing, is consummated in the immediate neighborhood of the lower critical range. It has for its object taking advantage of the phenomenon wherein the cementite constituent of the pearlite *balls up* or coalesces into globules, or minute *spheroids*. The treatment includes a long period of exposure of the steel to the temperature and re-

sults in extreme uniformity of structure conducive to free machining.

All true annealing processes involve heating the steel to a temperature

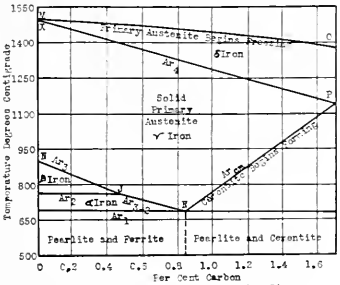


Fig. 1 - Critical Range or Iron-Carbon Diagram

above that of the transition of the existing structure (Alpha iron) to the Gamma phase. An iron-carbon diagram showing the phase-temperature relationship of reheated steel would be almost identical with that of Figure 1. The same critical lines would exist, but their respective positions would be each slightly higher, for phase transformations, as previously indicated, always lag behind temperature rise or fall. The lines, too, are designated as Ac lines rather than Ar lines. The differences are not sufficiently great to warrant reproduction in this, a general rather than specific, discussion, and the same criticals will be used for discussion of cooling phenomena.

In passing through the various critical ranges under the influence of reheating, steel undergoes phase changes the reverse of those attendant upon cooling from the liquid state. At Ar_1, the pearlite constituent is converted into the Gamma phase, austenite, of freely disseminated carbon in solid solution with iron. The grain structure is entirely broken down, and the grains exist in a state of maximum refinement. For steels of carbon content other than eutectoid proportions, either ferrite or cementite still exists in the original state of aggregation; and further heating, increasing as it does the absorption properties of austenite, brings about gradual transition of all of the excess material to austentite dissolution at the temperature coincident with initial rejection of the ferrite or cementite upon solidification. The coarse grain structure may persist for a long period of time after the steel has been brought entirely to austenitic state, so it must be soaked at the temperature of transition until complete rectification is assured—the assurance arising out of experience. Grain refinement cannot be forced by elevating the temperature more than just slightly above Ar_3, for the grains grow in size and with increased rapidity proportional to temperature rise above that required for complete austenitic conversion. Slow cooling with the furnace, in annealing boxes employed to prevent decarburization, or in air does not materially affect the refinement of the grain secured by annealing.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

THE Spring Banquet of the Armour Alumni Association, and the celebration of the twenty-fifth anniversary of graduation of the Class of 1910 will be held at the Medinah Athletic Club, 505 North Michigan Avenue, Tuesday, June 4, 1935, at 6:30 P. M.

This occasion should receive the support of every alumnus of the Institute, and it is hoped that many will be on hand to assist in making this affair as successful as that of the Fall Banquet.

One dollar and twenty-five cents will entitle you to your dinner—tax and tip included; so to assure yourself of a place in the dining room at such reasonable cost, make your reservation early.

Mail your request for tickets along with a check, to John J. Schommer, care of Armour Institute of Technology, several weeks in advance of the banquet.

The lounge off the dining room will be available before the banquet for meeting your former classmates, so arrange to be there as early as possible.

* * *

F. Noerenberg (Ch.E '34) is now connected with the Celluphoam Corporation of New Jersey.

Mr. H. C. Setterberg (C.E. '32) and Mr. E. F. Rutt (C.E. '29) are now in the U. S. Engineer Office at St. Paul, Minnesota.

* * *

Mr. F. E. Rutt (C.E. '31) is now in the Experimental Station at Iowa City, Iowa.

* * *

Mr. R. F. Stellar (C.E. '29) of the U. S. Engineer Office in Chicago, spoke before the student chapter of the Western Society of Engineers on the Illinois Waterway, March 15, 1935.

* * *

George Jennings Jr. (E.E. '31), former tennis star at Armour, played professional tennis in the U. of C. fieldhouse with Nusslein, Richards, and O'Connell.

* * *

Mr. Charles W. Collins (C.E. '12) is now Regional Manager of the Home Owners' Loan Corporation with offices in Chicago. He held the same official capacity at Detroit, Michigan, and also at New Haven, Connecticut.

* * *

C. A. Misura (M.E. '23) now employed at University City, Missouri, spent several days at the Institute visiting members of the faculty.

Under the auspices of Harold W. Johnson (C.E. '23), residing at 10744 Calumet Avenue,Chicago, Ill., the following Armour Alumni have been meeting at occasional conferences, lunches, etc.:

Mack Burkey (C.E. '24), 4363 Oakenwald Ave., Chicago, Appraisal Engineer First National Bank, Chicago.

C. W. Carlson (C.E. '23), 5401 S. Ellis Ave., Chicago, Sales Engineer Ill. Bell Telephone Co., Chicago.

F. G. Fredericks (C.E. '23), Chicago, Ass't. Engineer N. Y. Central R. R. Co., Chicago.

John J. Gordon (C.E. '23), 6839 Yale Avenue, Chicago, Maintenance Engineer Board of Education. Chicago.

Fred Hess (C.E. '23), 1297 Walnut St., Desplaines, Ill., Ass't. Engineer N. Y. Central R. R. Co., Chicago.

Robert S. Mayo (C.E. '23), Pittsburgh, Pa., Engineer in Charge of Construction Blaw-Knox Co., Pittsburg, Pa.

C. M. Myers (C.E. '23), 1416 N. Luna St., Chicago, Sales Engineer John T. Ryerson Co., Chicago.

W. H. O'Brien (C.E. '23), 6607 Greenwood Ave., Chicago, Promotional Engineer Southern Yellow Pine Association.

Geo. B. Stantial (Che.E. '23), 135 S. Elmwood Ave., Oak Park, Ill., Supt. of Foundries, Illinois Malleable Foundry Co., Chicago.

O. G. Smith (C.E. '23), 2118 Chase Ave., Chicago, Engr. of Buildings State Area, Ill. Bell Telephone Co., Chicago.

Henry W. Clausen (C.E. '04) died on March 3, 1935, in Boston, Mass. During the years 1907 to 1917, he was assistant city engineer in charge of water works construction, and until 1919, assistant city engineer. In 1919, he entered the employ of C. D. Osborn, first as office manager and engineer and finally as president. He is survived by his wife, a son, and a daughter.

We have heard much from the Detroit Alumni Association which seems to be the real thing in alumni organizations. A turnout of eighteen men, representing classes from 1897 to 1933, graced the meeting of April 2. Niel McIntyre Laney, the 1897 representative, entertained the members with some thoroughly enjoyed reminiscences. This was only one in a series of regular luncheon get-togethers on the first Tuesday of the month, and only one example of the success which has characterized these meetings.

The Association is hepped up over its bowling team, which is up at the top in the Intercollegiate Bowling League, and over the Armour Relays, which, they say, attracted considerable interest in the Detroit area. More power to organizations like this! The Institute is better off for them.

Many an alumnus who was formerly active in athletics at the Tech was seen roaming around the University of Chicago Field House during the Armour Relays last March 16.

Among those present who assisted John Schommer and Coach Stagg in handling the details of the meet were A. H. Jens (F.P.E. '31), V. A. Sturm (Ch.E. '30), Harry C. Setterberg (C.E. '32, L. Callen (C.E. '34), B. Hanson (M.E. '34), L. Frateschi (E.E. '34), Stan Lind (Ch.E. '32).

To those alumni who did not get to see this meet, it can be said that they missed a fine demonstration of track and field competition, events in which hundreds of men representing 30 or more colleges and universities in the middle-west were entered.

The big thrill for Armour Tech rooters came when the Medley relay team of Neal, Dunbar, Neuert, and Nelson stepped out to win the event,—and of course the gold medals—in the time of 4:33.3.

The Relays for next year are to be on a bigger scale than ever, with more schools entering full teams in competition for Relay honors. Arrange your schedule next Spring so that you will be able to attend this gala affair.

* * *

Theodore Gault (E.E. '34) is now working in Janesville, Wisconsin, for the Wisconsin Power and Light Co.

* * *

Leonard Peterson (F.P.E. '16) and Carl Grass (F.P.E. '16) have been recently promoted in the Insurance field.

John T. Paslawsky (E.E. '34) is an executive member of the newly-created Ukranian Central Committee, which is seeking to coordinate the activities of Chicago's Ukranian residents.

* * *

Robert P. Petersen (M.E. '27), an engineer at the Link-Belt Co., has been elected chairman of the Junior Engineers of the Western Society of Engineers for the season 1935-1936. W. N. Setterberg, Placement Officer at the Institute (Arch '29), was chairman during the season 1934-1935. Among other Armour graduates who are active in the affairs of the Western Society of Engineers are Frederick A. Hess (C.E. '23), R. F. Stellar (C.E. '29), Barry Kostenko (C.E. '34), Harold Davidson (C.E. '34), Roy Johnson (M.E. '34), Joseph Ferrara (M.E. '34), and Robert Suman (M.E. '34).

* * *

Eldon A. Johnson (C.E. '31) is now with the U. S. Engineer Office at Morris, Ill.

* * *

H. Bornstein (Ch.E. '11) delivered an address on "Advances In Gray Iron" at a recent meeting of the Western Society of Engineers. He is Chief Chemist and Metallurgist for Deere and Co., Moline, Illinois.

* * *

Earle W. Grover (E.E. '04) has been recently appointed Superintendent of Substations, Commonwealth Edison Co.

THE ARMOUR ENGINEER

Student Technical Publication of Armour Institute of Technology

VOLUME XXVI | MAY, 1935 | NUMBER 4

TO ALUMNI—Present and Future

THE Engineer of next year will be a new magazine, designed for service in the interest of students *and* alumni.

Talk of the long awaited creation of a New Armour, whose expanded facilities would render it of greater value to a community it has long served, bring strikingly to the fore an old question.

The new school, whenever built, would be physically a different Institute, but the spirit of progress which has characterized the history of Armour would change in no way. But in spite of this unified purpose, the Institute of the past is far from a unified body. A school in a large city, a school in which most of the student body is non-resident, naturally does not have as much alumni spirit as in the opposite case, but there is no reason to believe that the present alumni question at Armour should arise in such disquieting proportions at any school of importance.

For with an ever-increasing alumni body as larger and larger graduating classes leave the Institute, the Alumni Association still finds only a faithful ten per cent who show the faintest interest in alumni affairs. It is difficult to believe that college associates made so little impression on the other ninety per cent that it has drifted off into disintegration as an Armour Institute alumnus body.

The need is felt for some organ which will serve to bind together this scattered group, and some sort of news disseminator seems a likely tool for such a job. A number of interested men have raised serious doubts as to the capacity of a magazine like the Engineer to be put to use in such a task, and yet other projects sponsored as alumni periodicals have so far failed dismally.

The staff of the Engineer is going to try to prove that a publication of its purpose and content can serve as an alumni organ as well as discharging its present capacity. We are not sure of our success. But we are going to try to start a process of evolutionary progress through which, in time, a graduating senior at Armour would quite automatically choose to continue his connection with his alma mater through his alumni association—and through his alumni magazine, the Engineer.

Such a change in the magazine would not cause loss of interest from the student's point of view. It always will be the Engineer, a magazine for Engineers. But an alumni circulation of real volume would expand the facilities of the publication far beyond their present bounds. These things have a cyclic effect. A better alumni magazine will produce more alumni interest. More alumni interest will produce a still better magazine.

So the Engineer asks recognition of its new battle from alumni, both present and future. Definite steps to provoke alumni interest will be taken by the time of the next publication in November. We feel that the results of those and succeeding steps will be deserving of your cooperation in the establishment of an alumni and student —in short, an Armour magazine.

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

Modern Polyphase Induction Motors

By PUNGA and RAYDT
Translated by H. H. Hobart
Sir Isaac Pitman & Sons

DUE to their low first cost, high efficiency, and reliability in service, polyphase induction motors have come to be regarded as greatly superior to those using the single phase system. With the extension of the use of electric power the demand for these motors has become increasingly great, and the subject is therefore one which is of interest both to electrical engineers and to students in that field.

In this book, which is a translation from the German edition, the author has discussed in detail the underlying theory, advantages, and disadvantages of the various types of polyphase induction motors. While it has naturally been written with an eye to European practice and manufacturers, frequent reference is also made to American types. A short history of the development of this kind of motor is given in the introduction to the book.

A comparison between motors employing slip-ring armatures and those with cage armatures is drawn in one of the early chapters by showing the difference in the characteristic data and calculating a specific example of each type. The general theory and design of an induction motor having a double-cage armature, together with illustrations of the various types of construction of double-slot motors, are then taken up in detail. Means of switching over from starting circuit to running circuit in the rotor as well as the stator are also discussed. A description of the operation, construction, and use of centrifugal pulleys and couplings are given in the closing chapters, with specifications governing the connection of motors to supply circuits in Germany, France, Belgium, England, and Austria. Included in the appendix is a discussion of the means of so proportionng ordinary squirrel-cage motors as to reduce noise and low torque in starting.

The Design and Use of Instruments and Accurate Mechanism

By T. N. WHITEHEAD
The Macmillan Company

DISCUSSION of the theory and accuracy of instruments in this book applies not only to such common devices as micrometers, calipers, etc., but also to many kinds of light machinery, such as clock makers' precision lathes, subsidiary parts of print-

ing presses, and carburetors and magnetos of internal combustion engines. The subject matter is therefore of interest to designers and users of various instruments and those classes of light machinery which have the same essential characteristics.

The theory of errors and the design of instruments form the two general sections into which the subject matter is divided. In the first section a discussion is given relating to systematic errors, such as are caused by links in a mechanism which do not have the correct relation to each other: short period errors, or those which are caused by an outside force or vibration; and erratic errors, which are due to links whose relation to each other is not uniquely determined. A discussion of the laws of probability as applied to errors constitutes a chapter in this section.

In the second section of the book is included a discussion of precision and its relation to kinematic and semi-kinematic design, stiffness and protection of links and elements of instruments or mechanisms, and conditions and means for obtaining accuracy. Examples and descriptions of methods for planning an instrument are taken up in detail. There is also included a chapter on the human element and its relation to accuracy.

In writing this book the author has not attempted to give all of the fundamentals of each topic he discusses; rather he assumes some previous knowledge on the part of the reader of such subjects as kinematics and strength of materials. In this way stress is laid upon those sections of the material with which mechanical designers are likely to be less acquainted.

Besides its illustrations, graphs, and tables, the book contains very useful summaries at the end of each chapter.

Chemical Engineering Plant Design

By F. C. VILBRANDT

McGraw-Hill Book Company

CHEMICAL engineering design falls quite naturally into two divisions—equipment design and plant design—and this recent reference book takes up only the latter. That plant design is one of the really fundamental problems in any chemical engineering venture, and that an intelligently and carefully designed plant has a decided advantage over one which has grown up haphazardly, is obvious.

In the opening chapters, the volume deals with the development of the design project and the location of the plant with reference to both the technical and economic factors involved. In the following few sections the preliminary equipment of the chemical plant, such as foundations for units, piping, drainage systems, and pumping systems, are explained.

The first subject taken up in the strictly chemical engineering sections is the flow sheet and diagram, and, as an illustration, a complete list of data on a ferrous sulfate recovery plant is given. Selection of equipment,

plant layout, buildings, power, and power transmission follow in logical sequence. The final chapter deals with the subject of preconstruction cost accounting, with special stress on the comparative costs of various types of construction methods and equipment. The author also discusses the financial problems of capital costs and depreciation which are met with in a commercial chemical enterprise.

This book has been developed in such a way that it is equally as valuable to students in chemical engineering as to the experienced members of the profession. It is intended to be used in connection with specialized books on unit processes.

Lighting Culculation

By H. H. HIGBIE

John Wiley & Sons, Inc.

ILLUMINATION is a subject which only within recent years has come to be regarded as a definite branch of engineering, and in this recent volume the author presents as complete a discussion of the subject as has been written to date. Those interested in the field of illumination have long been in need of a reference book on this topic, which has usually been included merely as a section of a handbook of electrical engineering or architecture.

It has been the deplorable habit in the past to underestimate the importance of lighting science and art. But, according to the author, "next to teachers and books, lighting for seeing is the most important tool used in acquiring an education." It seems only logical, therefore, that the subject should be studied as scientifically as possible.

Scientific design of good illumination involves not only a knowledge of the physics, mathematics, and economics of light generation and control, but also the physiology of the visual sensation and its related processes, and the psychology of the mind which correlates, interprets, and evaluates the sensations. Obviously, this demands more of a background than is ever provided incidentally in courses of the fundamental sciences. Mr. Higbie admittedly believes that the student will find it demands independent and practical use of all the fundamental knowledge of light learned in physics, and the continuous exercise of his mathematical preparation over its entire range.

Since the volume is in the form of a text-book, it contains a great number of problems for the student—problems which are designed so that they cannot be solved parrot-fashion, by merely imitating an example. Replete with tables and diagrams, it leaves little to the inexact imagination.

Although it is equally as valuable to advanced workers as to beginners in the subject, the book does not assume previous knowledge on the part of the reader. From the fundamentals it passes to theory, and then proceeds to apply the theory to highly practical instances of all types of illumination, both interior and exterior.

ENGINEERING PROGRESS

NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

Silver in Chemical Apparatus

WHILE the resistance of silver to corrosion is known to every housewife, it was not until the depression reduced the price of silver that it came to be considered as a construction material in the chemical industry.

While silver cannot be used everywhere because it is attacked by hot nitric and sulfuric acids, its resistance to organic acids has led to numerous installations in food industries. In England it has been used in making pickles, vinegar, cider, and jam. The white vinegar obtained by distillation is especially improved by using silver, since copper coils always caused some discoloration. Acetic acid, the strongest constituent of vinegar, is also treated in silver stills, since many of its applications to synthesis require a very pure product.

Common ink has a very corrosive effect on metals as we see in the common use of gold for pens. The manufacture of ink, therefore, is another place where silver may be advantageously applied. Filling machines using silver are much less clogged than those using iron and rubber.

The cost of the silver installation may often be reduced by using linings .03 to .06 in. thick. These are applied to nickel or copper vats in the food industries, since it has been found impossible to get a sufficient coating by plating alone. Prices quoted indicate that where corrosion is strong, there is real economy in using silver.

Harder Centrifugal Castings

NITRIDING, the heat treatment of castings by ammonia at high temperatures, is now being applied to centrifugal castings such as are used in truck cylinder-liners where a hard and dense metal is required. The compact structure obtained by centrifugal casting has also made this method desirable in making large bushings, cylinder bodies for pumps handling corrosive liquids as in oil-well drilling, and capstans through which wire-drawing mills grade the finished wire.

The case hardening with ammonia gives the further advantage of a very hard surface which is unaffected at temperatures up to 950° F. In the process, the castings as they come from the centrifugal machines where they had been formed while rotating as fast

as 1400 r.p.m., are put into oil-fired furnaces in which they are heated to 1750 in an atmosphere of ammonia. On proper cooling, this treatment gives a surface hardness of 800 to 950 Firth diamond, together with a greatly increased tensile strength.

An interesting feature of the process is the method of keeping some parts from the action of ammonia. Cylinder liners of engines, for example, would require only the inner wall to be hardened; consequently, all the other surfaces are first plated with a thin coat of nickel to resist the nitriding. An alternative to plating is to use a paint containing powdered lead, tin, and zinc chloride, so that only the wearing surfaces are hardened by the ammonia.

Crystal Oscillator

A NEW crystal oscillator unit developed for municipal and police radio installations is said to be characterized by high frequency stability, compactness, and accessibility. The oscillator essentially consists of an aluminum casting into which the crystal oven, oscillator circuit, and oscillating tube are placed. Two handles, a thermometer, a frequency adjustment, and a type 10 oscillator tube, set into depressions so as not to protrude, are placed in front of the oscillator. The crystal oven, capable of a temperature constancy of +0.08° C, is insulated with balsa wood. The crystal is contained in a heavy metal holder, and the electrodes are spaced with quartz. The left section of the unit contains oscillating circuit coils, condensers, and resistors. The frequency adjustments consist of a miniature variable condenser connected in the oscillating circuit and arranged to give only a few cycles plus or minus from the base frequency of the crystal.

Aluminum plates at the top and bottom complete the shielding.

Cushioned Flexible Coupling

A NEW flexible coupling, having individual free-floating load cushions hung between jaws on removable studs, has been made.

The cushion material must meet three specifications: 1—A brake-lining material used for heavy shock loads; 2—Leather load cushions for use on sustained loads and greater misalinements; 3—A rubber-duck fabric, vulcanized under pressure for use on fluctuating loads and where high resilience is required.

The load cushions are in plain sight for inspection at all times and can easily be removed and replaced. There is no wear on the steel jaws and no lubrication is required.

When in operation one half of the cushions are idle, except on reverse load, hence there is always a new set of cushions in the coupling. As the

load cushions can be easily and quickly interchanged without tearing down the coupling, shut-downs are eliminated. The principle involved in the carrying of the load on the free-floating load cushions is said to have been thoroughly investigated and tested for a number of years.

Metal to Glass Joints

THE problem of joining two dissimilar materials like glass and metals has come nearer to practical solution by two recent discoveries in glass technology. The first process is simply a method of soldering glass tops on tin cans. Without the use of any gasket, this allows a close seal to be made between the glass and tin producing a joint that is stronger than the glass itself. In tests made in canning factories, it was found that the glass-topped cans could even be overheated in an autoclave and then suddenly cooled by a stream of cold water without damaging the can.

Another method of solving the metal-to-glass problem is by a recently developed metallic alloy. Not only does this have the same expansion coefficient as glass, but it can also be machined, soldered, forged, and stamped as readily as nickel alloys. While it has been applied mainly to vacuum tubes and other devices which require a gas-tight seal, other experiments indicate wider possible applications for this new material.

Thyratron Motor

ELECTRONICS has made possible a significant development in the field of power production. By using thyratron tubes, a new type of motor has been given the characteristics of a series type d-c. machine while operating on an a-c. power source.

The motor is equipped with the stationary type of armature and a revolving field that is common in the synchronous motor. This armature, however, is provided with a special winding and a group of full wave rectifiers carrying three phase, 60 cycle current, thereby providing unidirectional current. A small distributor placed on one end of the motor shaft controls the thyratron grids so as to rectify the current. The rectification provides for the production of power in the proper sequence and quantity so as to produce the correct torque. In addition to the governing rectification the thyratrons act as commutators and thereby perform an important function in the control of the speed.

This end is accomplished by the means of variation of voltage, this being accomplished by shifting the phase by means of grid control. This method insures a smooth variation of speed over the entire range for which the motor is designed. Also, this device makes the speed of the motor independent of the frequency of the power supply. By means of the commutator function of the thyratrons, the smooth

variable speed-torque characteristics of a d-c. motor are obtainable, even without taking regard of the synchronism of the power source. Similarly, the rectifier function of the electron tubes supplies the motor with a continuous power control over the complete power range of the motor with a minimum power loss in the resistance.

Asbestos Bearings

A VULCANIZED composition of asbestos, graphite, and rubber has been developed as a new bearing material for under-water operation. It is a tough but readily machined product which has a low coefficient of friction, even though unlubricated. Water is its best lubricant.

It fills a long-felt need in industry for a bearing material which does not require the use of commonly employed lubricants, and for numerous other uses where its mechanical strength, low coefficient of friction, increased efficiency in the presence of moisture, and long wearing qualities make it unique.

In the paper industry, aside from bearings which run in water, this material is used for increased efficiency and economy on the wet end of the paper machines.

Roll-Type Pyrometers

FOR measuring surface temperatures of revolving rolls and cylinders a new roll type pyrometer has been invented. The unit is self-contained, and the indicator is mounted in a supporting arm which also holds the ribbon type thermo-couple. The thermo-couple consists of a ribbon or flat strip type wire which is placed directly in contact with the revolving roll. This ribbon thermo-couple is held in a bow-shaped assembly which provides suitable tension, thus enabling the thermo-couple to be used on a revolving roll regardless of the diameter of the roll.

To the thermo-couple assembly is attached a grooved carbon block. This carbon block will prevent excessive pressure of the thermo-couple against the roll.

The thermo-couple assembly, being provided with three adjustments, can be turned, by means of set screws, in either direction in relation to the extension arm in three different positions.

A rugged millivoltmeter having a case diameter of four and one-half inches is all the indicator consists of. The scale length is three and one-half inches and can be graduated as desired. The instrument can be equipped with an additional automatic cold end compensator for atmospheric or room temperature variations.

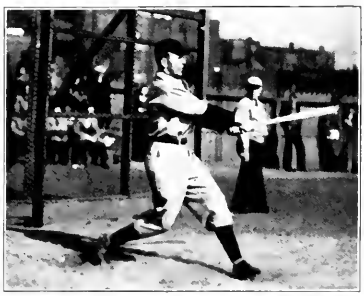
THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Baseball

A DISASTROUS early season campaign has given the Tech baseball squad the earmarks of a loser for the first time in years. Four crushing defeats by Chicago, Northwestern, Hillsdale and North Central have, at this writing, thrown a gloom over the campus.

Like some other Chicago baseball teams, the Armour nine looks better on paper than on the field. Adamec in the outfield; Lauchiskis, Biegler, and Tad Omiecinski in the inner regions;



J. M. Bard

Baumel on the mound; and Bartusek and Phillips behind the bat, form a nucleus of veterans whose February prospects belied their April staggerings.

The graduation of Lefty Mayer was undoubtedly a bad blow along with the departure of several other of last year's stars, but the 1935 squad has been weakest in the hitting and fielding departments. Even Mayer couldn't have handled all of that.

It is hoped that when this appears in print there shall have been a complete reversal of form. The squad has the potentialities of a winner. Perhaps the May sun will bring a few to light.

Wrestling

Armour's worthy matmen finished up a most successful season by adding another victory to their list. This win brought the season's total to eight wins and four losses, their best year.

Of all the good men on the team Captain Schmidt turned in the best record, twelve wins and not a loss. Of these twelve, eight were won on falls and pins and four were on time. His performance was consistent with his position as captain and his leadership meant much in the successful year.

Kreml and Sumner also came in for their share of the praise, each with nine winning counters. These bouts helped a good deal in determining whether Armour was to win or lose western, DePaul, Beloit, Chicago,

in many of its meets. Another man who has shown up surprisingly well for a newcomer is Jimmie Dunne of the green-hats who captured seven wins and lost but five. This is Dunne's first year and yet he ranks as fourth highest in the scoring column.

Other men who added to the wins were Peterson, wrestling in the heavyweight division with plenty of color, and Hella, in the 112 pound section. There are also several other men who, though they didn't add substantially to the team's victories, can be counted upon to help next year now that they have gained a little experience.

After the meet, the wrestlers elected Herm Sumner to captain next year's squad. Herm has seen three seasons on the team and all have been productive of letters. Anthony Majercik will succeed George Wheaton as manager and hopes to duplicate George's fine work in arranging this sport.

Swimming

Swimming at Armour has ended rather unsuccessfully, but, nevertheless, the plans and anticipations for next year are not the least bit downcast. A meeting of members of the team was held and in view of his excellent work of this and last year, Roger Knaus was unanimously chosen the captain for the forthcoming season.

Throughout the entire schedule of nine meets, Armour failed to enter one where it was not incapacitated by the sickness of one or more of its main supports. Needless to say, this has been instrumental in cutting down the team's average to two wins and seven losses. Although the tankers will be noticeably weakened by the graduation of Ahern, Bernstein, Moore, and Lyford, it is hoped that the boys on the team will be able to carry on the job with the assistance of some new material.

Coach McGillivray announces that Ahern, Bernstein, Knaus, and Moore have been awarded major letters; Ruekberg, Duerrstein, Tallafuss, and Stehman, minors; and Bob Lyford, a sweater.

Golf

With the advent of spring the members of the golf team are polishing up their clubs and are anticipating with unholy glee the pleasure of knocking the small white pill around. Professor Bibb has been selected to replace Professor Leigh as coach, and he will be assisted in his work by Manager Howard Zibble. It is hoped that this season will be as successful as last and that the splendid playing of last year's squad will be continued during this season's schedule.

The four returning lettermen are Ahern, Richards, Shanahan, and Davidson. Last year's record was pretty fine with six wins and two losses, the losses being to Northwestern and Chicago. The team this year will consist of six men, thus leaving two places to be filled by aspirant Bobby Joneses. A tentative schedule released by Manager Zibble includes meets with North-

South Side Jr. College, and the Alumni. Practicing will be on the fairways of the Southmoor golf course, and the call to arms will be issued shortly.

Tennis

The Tech netmen are beginning to warm up and from the signs of activity on the Wentworth courts they are plenty hot. Armsbury, Lammers, and Esbensen comprise the trio of returning lettermen whose efforts will be assisted by such promising talent as Herb Arnold, last year's tournament winner, Henry Bodnar, the runner-up, Gus Freund, Ed Schmidt, George Quandee, J. K. Morrison, and several others who have not as yet come out for practice. The actual team will consist of six men, and the first meet of the season is scheduled to take place in the last week of April. Tennis was a rather successful sport last year, the men garnering four wins and three losses.

J. M. Bard

Track

In closing their indoor season, an Armour contingent attended the Butler Relays at Indianapolis. Those who made the trip were Neal, Dunbar, Neuert, and Nelson, winners in the one mile relay event at the Armour relays, and Friede, Faust, Rigoni, and Roberts, captain.

With the outdoor season under way, Coach Stagg hopes to better the standing made by the team in indoor track with the new men who have not as yet made their appearance.

Junior Week

Something like twenty-five years of annual repitition has failed to mar the zest of Junior Week at Armour. Not radically unlike any of its long line of predecessors, the 1935 edition of the annual Tech carnival will give the senior the same thrill which he had as a freshman, and which the present freshmen are for the first time experiencing.

The addition of the green tops in the last two years has added a little extra punch (literally as well as in the vernacular) to the freshman-sophomore hostilities which rage through the week to a climax on Friday afternoon when the annual rush takes the last bit of pugnacity out of all contenders.

The interfraternity and interclass competition, Open House night, the spring concert, annual distribution of the Cycle,—all these things and many more are what make the last four weeks of school tougher than ever. This year's staff of Junior Marshals under Roy Peterson has prepared a week which will support the tradition.

And say, Bill, you didn't do your Calc, did you?

Tau Beta Pi

Tau Beta Pi, the national honorary engineering fraternity, pledged the following men:

R. R. Johnson, '36
R. M. Paulsen, '36
F. D. Cotterman, '36
H. S. Nachman, '36
H. P. Milleville, '36
R. A. Peterson, '36
W. W. Henning, '35

Sphinx

Seven men who have been outstanding in their work on the publications at Armour were pledged to Sphinx, honorary literary society. They are N. Balai, C. L. DuSell, G. Freund, R. H. Knabe, J. O. Larson, R. O. Patterson, and G. A. Zwissler.

Alpha Chi Sigma

Alpha Chi Sigma, professional chemical fraternity, announces the pledging on March 18 of the following men: J. Haase, F. Harman, J. Kahles, W. Schreiber, P. Schultz, B. Wilhelm.

The fraternity held a smoker on Wednesday, March 13, at the Beta Psi house which was well attended by the alumni members, several of whom are now doing research work at Armour, as well as the prospective pledges.

Pi Tau Sigma

Pi Tau Sigma, honorary mechanical engineering society, held a pledging in the Truss Club rooms on Thursday, March 21. E. P. Auler, D. E. Howell, A. M. Lane, A. H. Rice, and F. L. Smith were the pledges. Each of them had been given a problem to be solved in a week's time.

W. W. Henning's talk on "Torsional Vibrations in Automobile Crankshafts" was chosen as the best talk given at the A. S. M. E. meetings this year. He has represented Armour at the national meeting of the A. S. M. E. in Chicago, April 29. Three cash awards of fifty, twenty-five, and ten dollars will be given for the best talks at this meeting.

Honor "A"

Twelve men were pledged by Honor "A" in reward for their excellent sports records.

Joseph Bartusek, Louis Biegler, Ken Carroll, William Concolino, Robert Esbensen, Eugene Heike, Robert Hella, Robert Merz, Daniel Moore, Donald Neal, Robert Schmidt, and Hermon Sumner were the athletes who took the pledge.

Chi Epsilon

Chi Epsilon, honorary civil engineering fraternity, pledged four men, John Galandak, John Larson, Theodore Ramotowski, and Gordon Zwissler. Pledging took place in the rooms of the Campus Club. The period of pledging will probably extend about one month before their initiation.

A. I. Ch. E.

Three interesting lectures are to be presented within the next month through the efforts of the A. I. Ch. E.

Dr. Balke of the Fasteel Products Company will talk on the properties of tantalum alloys, Mr. Nash of the Nekoosa Paper Company will lecture on paper, and Mr. F. W. Maynard of the National Lead Company will give a talk accompanied by moving pictures, for the benefit of the Institute's members.

A. S. M. E.

Fifty members of the Armour branch of the American Society of Mechanical Engineers visited two of Milwaukee's large industrial plants on their inspection trip Wednesday, April 10.

The first plant visited was that of the Allis-Chalmers company, makers of farming equipment, pumps, turbines, and similar products. The major project under construction at the time of the visit was the turbo-generating equipment for the Boulder Dam.

In the afternoon of the same day, the factory of A. O. Smith, manufacturers of steel products, was visited. However, because a new set-up was being prepared, the plant was not in operation. The A. O. Smith Company's chief product is steel automobile frames.

Western Society of Engineers

Dr. George L. Scherger, former head of the department of history and political science at Armour, spoke at the weekly meeting of the Junior chapter of the Western Society of Engineers Thursday, March 28. His subject was "What's Wrong with the World?"

Courtesy—Haynes Publicatio

Expanding the Sulfur Market (see p. 47)

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF THE AUTHORS AND PUBLISHERS

Corrosion of Bearing Surfaces

By H. BIERBAUM

(From "Mechanical Engineering," April, 1935)

THE oxidation of oils on bearing surfaces changes a chemically neutral oil to one having a distinctly acid reaction. The degree of acidity depends upon the extent of oxidation. The acidity produces two effects: it changes the oil from an indifferent or non-wetting to a wetting oil, and the acidity of the oil produces a corrosive action upon the bearing surfaces.

The chemical reactions involved are very complex. In some cases the oil appears to act by catalysis only, requiring air to be mixed with the oil to produce a corroding action. The degree of oxidation also affects the capacity of an oil to emulsify with water, and, in most cases, the emulsified water intensifies the corrosion. Oxidation increases with an increase in temperature, and since the oil film is always at a high temperature, the bearings are subject to rapid corrosion.

The amount of oxidation of an oil can be found by placing a small amount of the oxidized oil on the surface of acidulated water. The oxidized molecules of oil have an attraction for this water and tend to spread out in a monomolecular film. This film is invisible but the rate of absorption can be readily observed by dusting the water with fine talcum. The rate of spreading of a known amount of oil gives a measure of the degree of oxidation.

The chemical reaction upon the surface of the bearing is more often non-uniform and selective in form. If the corrosion is selective, attacking the softer crystals of the metal only, the effect is largely beneficial because it insures an increased amount of lubricant in the oil film. On the other hand, if the corrosion is general, attacking all crystals alike, the effect is very destructive, shortening the life of the bearing. Corrosion is the result of the presence of sulphur and the fatty acids, even though in very small amounts.

Properties of Tires, Affecting Riding, Steering and Handling

By R. D. Evans

(From S.A.E. Journal, Feb., 1935)

"FUNDAMENTALLY, driving an automobile consists in maintaining appropriate control over a somewhat complex and ever-changing system of forces. In the last analysis these forces all center or focus at the area of contact between the tire and

the road." The problem of control of these forces determines the properties of the tire.

The functions of an automobile vehicle tire are:

1. To carry the weight of the vehicle, to cushion it over road irregularities, and to eliminate noise;
2. To provide sufficient traction for accelerating, driving, and braking; and
3. To provide adequate steering control at high speeds.

The ability of a tire to fulfil the latter function is termed the "cornering power" of the tire and is the most important contribution towards its "roadability." These functions imply the two indispensible characteristics of a tire, cornering and cushioning.

The basic principle in tire design is the so-called "Tripod of tire performance—cornering, cushioning, and durability." An improvement of any one of these entities is apt to be at the expense of the others, and likely to disturb the level of satisfactory operation. For example, a reduction of inflation pressure increases the cushioning power but reduces the cornering power. Cushioning demands flexibility of the tire while cornering demands rigidity of the same structure. Durability considerations are usually at odds with both cornering and cushioning.

Analysis of the forces acting, results in the logical resolution into components with the following probable results:

1. A vertical or radial force between the road and the tire perpendicular to the area of contact;
2. A tractive or rolling resistance force in the plane of the contact area; and
3. A lateral or cornering force in the plane of the contact area, but directed, at each instant, at right angles to the path of travel of the tire and vehicle.

These forces (2 and 3) depend ultimately upon the existence of friction between the tire and roadway, and, therefore, can possess magnitude only when force (1) exists. High speeds of the present day demand an ever increasing amount of lateral forces, and, hence, increase the importance of cornering power.

Cornering power is the ability of a tire to develop side load or lateral thrust and is that property which permits steering around a curved path at high speed, and, conversely, it is that property which holds the car in a substantially straight path when it is acted upon by other incidental lateral force such as wind.

The factors affecting cornering power are the variation of the wheel camber as the car travels about a curve, the magnitude of the slip angle, the magnitude of the radial load on the tire, the centrifugal effects of curves which increase with the speed, the inflation pressure of the tire, the flange to flange rim width of the tire, and the size of the tire.

Other tire properties relative to steering control are concerned with the reactions in the vehicle itself. They are:

1. Precession torque—the effort of the advancing tire to align itself parallel to the path in which it is compelled to move; and
2. Static torque — the maximum twisting effort required to twist the tire, standing under load on a level surface, around a vertical axis.

Four conclusions determine the mechanism of the cornering power.

1. The upper limit of cornering force is determined by the available friction which, in turn, depends on the coefficient of friction, the unit pressure, and the radial load.
2. The magnitude of the cornering force depends on the lateral rigidity of the tire structure under the conditions of radial deflections which are obtained.
3. Cornering force depends on the amount of distortion of the tire, which is approximately proportional to the slip-angle and to the effective length of the contact area.
4. Cornering power should depend very little, if any, on speed.

Cushioning power is concerned with the perturbations of the radial load to which cushioning ability is related. It depends upon the ability of a tire in rolling over a road obstacle or irregularity to absorb the irregularities with the least possible delivery of additional force to the rim and wheel.

Durability is also concerned with the radial load on the tire, and centers about the familiar tread wear, the most important aspect of tire performance. The present day trend for more abrasive, non-skid types of roadway, and the effects of the roadway in the many hot, dry climatic regions, tend to increase the wear on a tire. It is also interesting to note that generally the wear on the rear tires is greater than that on the front, that tire wear on the right side of the vehicle is greater than on the left side, and that the wear depends upon the car, especially in the case of the new types with independent front wheel suspension.

Behavior of Oxidizing Agents with Activated Carbon

By A. S. BEHRMAN and H. GUSTAFSON

(From Industrial & Engineering Chemistry, April, 1935)

IN THE past few years engineers have become well acquainted with activated carbon, chiefly through their use of this material in water purification. In general, it is utilized for this end in two ways, to absorb such substances as phenols, chloro-phenols, and decomposition products of algae and other microörganisms, and for the removal of free chlorine, which may be present in small amounts for sterile measures, or in large amounts to oxidize organic matter.

The behavior of activated carbon

with oxidizing agents may be classified in three divisions:

1. Adsorption and catalytic decomposition of the oxidizing agent.
2. Adsorption of the oxidizing agent accompanied by reaction with the carbon:
   a. With release of the reaction products from the carbon.
   b. With retention of at least one reaction product in the carbon.
3. Adsorption and retention of the oxidizing agent unaccompanied by chemical reaction with the carbon.

A reaction of the first type is illustrated by the action on an aqueous solution of hydrogen peroxide. Mere contacting frees the solution of the peroxide.

The second type of reaction may be represented by the following equation:

$$2\ Cl_2 + C + 2\ H_2O = 4\ HCl + CO_2$$

Adsorption is an important part of this reaction. Bromine reacts similarly, although more slowly. In both cases, a low pH favors the formation of the halide from the free halogen.

The second part of the reaction may be illustrated with potassium permanganate. Such a solution can be completely decolorized by activated carbon, leaving very little manganese in the clear solution. The activated carbon reduces the permanganate to manganese dioxide.

The adsorption of oxidizing agents without reaction presents a wide field for practical use. Substantially complete recovery of iodine present in concentrations of much less than 50 parts per million can be effected with activated carbon, a low pH being essential. A good grade of the activated carbon can adsorb as much as 25 to 30 per cent of its weight of iodine.

The "Micropter" Torsionmeter

(From Engineering, March 8, 1935)

THE entrance of the steam turbine into the field of marine propulsion necessitated the development of a new method for determining the shaft horsepower. The only practical method for use at sea is to measure the torsional deflection or twist of the shaft under the applied torque. It is necessary to average measurements of deflection at several angular positions as cyclic changes of torque occur during one revolution.

The apparatus, the micropter, which fulfills these requirements, consists of two cast iron sleeves for use with small size shafts and permanent installations. Aluminum or other light alloy sleeves are used for test purposes on temporary installations. The outer ends of each sleeve are clamped to a collar forged to the shaft, while the inner ends are entirely free and about one inch apart. On the inner side of the left sleeve is a slide-mounted, center zero glass scale, calibrated in one-thousandths of an inch. The scale is illuminated during rotation by a series

of lamps mounted on an adjacent, stationary, cylindrical shell fixed to the ship's structure. The light is reflected downward through the scale into the objective of a special microscope mounted on the right sleeve. Both the microscope and the scale are adequately counterbalanced on their respective sleeves. The microscope objective, with its axis radial to the shaft, is mounted perpendicular to a tubular body whose axis is parallel to the shaft axis. A pentagonal prism, mounted under the objective reflects the light rays to the opposite end of the tube through a glass diaphragm, on which is engraved a fiducial line, and then through a right-angle prism to a special form of eyepiece. The reading is actually observed through a series of eyecups fitted with two plane glass windows, to protect the eye from draughts, and mounted on the fixed casing in line with the light. The microscope is accurately focused when the shaft is at rest and the position is carefully clamped on the objective tube so as to prevent any subsequent motion from altering the focus. Coincidence between the center-zero line and the fiducial line is also requisite prior to the commencement of a test.

The rotating shaft transmitting the torque causes a relative movement between the miscroscope and the scale, resulting in a fiducial line movement over the latter by an amount depending upon the torsional deflection. Despite the fact that the eye at one of the eyecups sees the scale and line only momentarily per revolution, the phenomena of visual persistance assists the observer, and makes possible the obtaining of readings at speeds as low as 30 R.P.M. Similar observations are made at each eyepiece, and the mean value obtained used as the actual torsional deflection.

Using for G, the modulus of elasticity, a value of 11,930,000 lb per square inch, the shaft horsepower may be calculated as follows:

$$\text{H. P.} = \frac{18.58\,(D^4 - d^4)\,NM}{LR}$$

where D is the external diameter of the shaft, d is the internal diameter, L is the length of shaft over which deflection was observed, R is the radius of the scale, M is the mean scale reading, and N is the R.P.M. All measurements are in inches.

Expending the Sulphur Market Through Research

By W. E. BALL

(From Chemical Industries, March, 1935)

AMERICAN sulphur producers are now carrying on extensive research in an attempt to find new uses and markets for sulphur. Two promising uses that have been applied successfully are: the spraying of crops, to check weed growth, and spraying of roadsides with dilute sulphuric acid. Results show the acid is as effective as oil in use on roadsides and is also cheaper.

Europe has been using the acid

spray for several years, and its use is spreading. The National Research Council of Canada and the grain producers of Argentine are also investigating its use. A group of sulphuric acid manufacturers in England have organized a society to do contract spraying for farmers as a means of introducing this new method. A similar organization is contemplated by the Freeport Sulphur Company in this country.

The effectiveness of the spray is clearly shown in the following data:

Treatment	% Concentration of H_2SO_4	Bushels of grain per acre	% increase in yield
1	5	61.53	28.72
2	5	60.10	29.16
3	5	72.52	57.77
4	7.5	64.70	39.09
5	7.5	69.69	52.05
6	7.5	74.65	68.89
7	10	70.88	61.56
8	10	71.45	60.58
9	10	71.23	60.91
10	..	38.27	
11	..	49.49	
12	..	53.73	

10, 11, 12 are unsprayed areas; the average of the three was used as a basis for comparison.

Other excellent features of this new method of spraying are the small investment required in spraying equipment, and the crop is not tangled. The erect condition of the crop causes an increase in the crop yield.

Adoption of this method of weed control in California alone, on a scale similar to that used in France, would increase domestic sulphur consumption by two or three per cent.

Synchronous Motors

By CHARLES C. SHUTT

(From Factory Management and Maintenance, Feb., 1935)

SELECTION of a high-speed synchronous motor for an industrial drive involves a choice of a wide range of types, especially in regard to starting performance. The problem may involve limitations of starting current, or necessitate the controlling of the torque during the starting period in order to protect belts and gears from excessive acceleration, or a combination of both of these limitations.

The most common limitation is that of a permissable starting current. Where high starting torque with low current is required, the problem becomes one of choosing a motor possessing a high ratio between torque and current. The highest value of this ratio may be obtained by interposing a magnetic clutch between the load and the motor. The chief disadvantage to this is that the clutch linings wear excessively.

To meet the requirements of power companies in regard to starting high speed motors, a manufacturer may resort to an older method of starting: the use of an auxiliary starting motor.

In many plants, high-speed motors are belted directly to line shafts. In this case, it is desirable to control the torque on starting so that the belt first tightens, and then a higher torque is

applied so as to overcome the inertia forces of the machinery driven by the motor.

When control of torque is required without severe limitations on the starting current, it may be secured by the use of a standard motor with a series tapped reactor or resistance. One of the most satisfying series for the control of torque is the saturated core reactor. These reactors are of the saturated iron core type and possess an auxiliary winding through which direct current is passed. These coils are permanently left in the circuit. The torque is controlled by varying the direct current excitation of the reactors which may be accomplished by an automatic or hand operated direct current rheostat.

The Increasing Applications of Hard-Facing

(From Machinery, February, 1935)

HARD-FACING may be defined as a process of welding to wearing parts, a coating, edge, or point of metal that is highly resistant to abrasion, shock, or high temperatures. Hard-faced surfaces outlast steel from two to twenty-five times. As a rule, hard-facing is not applied until the wearing parts are badly worn in service, but it may be applied to new parts before installation.

There are three general groups of hard-facing materials, one of which is a high alloy steel having considerable strength and toughness, but possessing a comparatively small resistance to abrasion. Materials of this group are used for hard-facing gyratory crusher mantles, crusher jaws, dipper teeth, and similar parts which are subjected to severe shock and impact.

Another class consists of the tungsten carbide, the so-called diamond substitutes. These cannot be applied by welding, but are held in place by a binding material. These substances have found widespread uses for hard-facing oil-well drilling tools.

The third class consists of non-ferrous alloys of cobalt, chromium and tungsten. These are most important to the steel industry, because of the prevailing high temperatures. These alloys are abrasion resistant and maintain their hardness at high temperatures. They have excellent welding properties and a small coefficient of friction.

Hard-facing materials may be applied by the oxy-acetylene or the electric arc methods. For the non-ferrous alloys and many of the ferrous alloys, oxy-acetylene method is recommended. Practically all types of metals can be faced with non-ferrous welding rod, but three important conditions must be kept in mind: (1) the surface to be faced must be absolutely clean; (2) an excess acetylene flame should be used; (3) the surface should be brought to a sweating heat only and not melted.

A prisoner was being led off to execution by a squad of Bolshevik soldiers. It was raining heavily.

"What beasts you Bolsheviks are," grumbled the doomed one, "to march me through the rain like this."

"How about us," retorted one of the squad. "We have to march back through it."

* * *

And then there was the Sophomore who thought he got the wrong report card. He claimed the one sent him should have gone to Dizzy Dean, because it was all "I's".

* * *

Overheard at the Freshman-Sophomore Dance:

"You ought to duck that girl you're with."

"Duck her! I'm going to drown her."

* * *

When is a joke not a joke?

Nine times out of ten.

* * *

"Hello, is this the weather bureau? How about that shower tonight?"

"Don't ask us. If you need one, take it."

* * *

There was a lot more horse sense on the highways in the old days, but it belonged to the horse.

Mr. Smith had just finished putting the seeds in the garden.

"How about the birds eating the seeds?" asked Mrs. Smith. "Hadn't you better put up a scarecrow?"

"Oh, that doesn't matter," was the reply. "One of us will always be in the garden."

* * *

"Don't cry, sonny, grandpa will play Indian with you."

"B-but y-you won't d-do any good. Y-you're scalped already."

* * *

Professor: "Give me some of that prepared monoaceticacidester of salicylic acid."

Druggist: "Do you mean aspirin?"

Professor: "Yes, I never can think of that name."

* * *

She: "Did I ever show you the place where I hurt my hip."

He: "No, No."

She: "All right, we'll drive over there."

* * *

Lecturer: "I say again, ladies and gentlemen, we're having too many hasty courtships and whirlwind marriages."

Frosh: "Sure it isn't the other way around, prof?"

Streamlined Piping

Oxy-acetylene welding and cutting add a new note of grace and efficiency in modern piping systems.

By G. O. CARTER*

NOWADAYS everything is being "streamlined" — airplanes, automobiles, trains, ships, approach their greatest degree of grace and efficiency through this design principle. Usually their streamlining is all on the outside. Piping joined by welding is streamlined both inside and outside.

WELDED ASSEMBLIES such as this loop in a steam line are easily made.

100,000 Miles Installed

Welded joints were first used for river crossings in oil pipe lines. They proved strong and sturdy enough to withstand the shocks of this difficult service. Soon welding came into general use for every joint in the line. Today over 100,000 miles of welded pipe carry oil, gas and gasoline over the country.

The economies which welding brought to the construction and maintenance of pipe lines led to its adoption for power plant and industrial piping. Now it is the first choice of many engineers for all kinds of piping.

Prevents Leakage Loss

Streamlined welded piping has many attractive features besides its smooth lines. Welding is sound, safe, and in the final analysis, the most economical way of putting pipe together.

Welding makes a "jointless" job—insures the owner from future maintenance. Permanence is so positive that in the Cathedral of St. John the Divine in New York, welded piping has been installed in masonry walls fourteen feet thick. In other instances coils of welded piping have been set directly in plaster in the ceilings and walls of beautiful residences. Modern skyscrapers enclose mile upon mile of welded piping. In one building group in the East there are over 85 miles of welded steam piping alone.

Avoids Friction

Pipe joined by welding is smooth inside and outside—truly streamlined. The smooth outside makes insulation less costly and easier to apply. The smooth inside makes friction negligible and reduces power losses. Welded piping is now used for gases and liquids of all sorts and for many solids—requiring pipe of every size and of almost every metal.

Permanent but Flexible

To be a sound investment today, buildings must remain relatively free from maintenance. Piping must be permanent, strong, leakproof and reasonable in cost.

SINUOUS CURVES of welded pipe sweep from floor to floor carrying steam, water, gases and liquids.

Welded piping is permanent. But alterations can be made easily when desired. The oxy-acetylene cutting blowpipe gives the ready means of making an opening. The addition is then tied-in simply by means of welding. This is especially important in the modernization of old buildings.

Installation Facilities Everywhere

The Linde Air Products Company, a Unit of Union Carbide and Carbon Corporation, has pioneered many applications of the oxy-acetylene process in pipe welding. Without cost or obligation to you, it will gladly furnish complete data on welded piping methods. It will make available also such further technical assistance your engineers or construction men may require. Linde Sales Offices are located at Atlanta, Baltimore, Birmingham, Boston, Buffalo, Butte, Chicago, Cleveland, Dallas, Denver, Detroit, El Paso, Houston, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Phoenix, Pittsburgh, Portland, Ore., St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, and Tulsa.

Everything for oxy-acetylene welding and cutting — including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through producing plants and warehouse stocks, everywhere.

"JOINTLESS"—With a safe, simple and portable oxy-acetylene welding and cutting outfit and suitable welding rods, pipe of any size, any commercial metal, is assembled rapidly into sound jointless piping systems.

*Consulting Engineer, The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.

"WHEN I kissed her I smelled tobacco on her lips."

"You object to your girl smoking?"

"No, but she doesn't smoke."

* * *

The manager of the big office stamped furiously up and down his room as he waited for his office boy to appear. The boy entered the room.

"Why hasn't this job been done?" snapped the manager. "I told you a month ago to get it done."

"I forgot, sir," returned the boy, nervously.

"Forgot, forgot?" raved the manager. "Suppose I forgot to pay you, what would you say?"

"I should come and tell you at once," returned the culprit, "not wait a month and then kick up a fuss about it."

* * *

Voice over telephone: "Is this the lady who washes."

Society Snob: "Indeed, I should say not."

Same voice: "Why you dirty thing."

"With whom was your wife quarreling last night?"

"Oh—er—she was scolding the dog."

"Poor beast—I heard her threaten to take the front door key away from him."

* * *

His fellow clerks gathered around him when the news of his engagement became public property and extended congratulations.

"But," said the man, "I understand the girl you are engaged to is a twin. How do you tell the difference between her and her sister?"

"Well, it's a jolly family," said the lucky man, "and I don't bother very much."

* * *

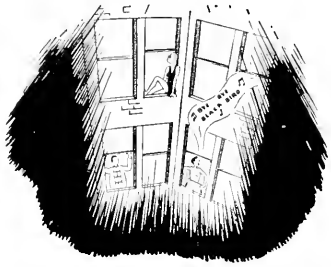
The best jokes are not printed here. They walk around on two legs.

* * *

He (very disgustedly): "I think I've got a flat tire."

She: Oh give me a chance. We're not a block away from home yet."

G-E *Campus News*



SYNTHETIC SUNLIGHT

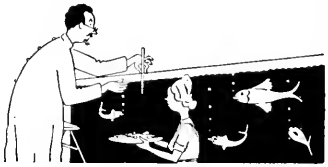
THE people whose apartments faced the lower levels of the ventilating shafts in a 14-story New York apartment house had long ago given up the hope that direct sunlight would enter their windows. Imagine their astonishment one morning not long ago to find light — lots of it — streaming in. When they looked, they found not the sun, but 18 of the sun's able little imitators—General Electric floodlights. They had been mounted on the ninth-floor level.

The engineers were thoughtful of the tenants' feelings. For when the switch is thrown no sudden glare of light paralyzes unaccustomed householders in the act of brushing their teeth or doing setting up exercises, pastimes which were formerly cloaked in intimate gloom. A fully automatic synchronous-motor time switch actuates a dimmer, and the floodlights do not attain full brilliancy for 15 minutes.

GROANING RAILS

A FEW weeks ago, the rails between Schenectady and Benning, D. C., groaned under what is believed to be the heaviest load ever transported on a single car. The load consisted of the generator shaft, rotor, and poles for a General Electric frequency converter set being installed at the plant of the Potomac Electric Light and Power Company to deliver 25-cycle, single-phase power to the Pennsylvania Railroad. The total weight on the rails was 471,300 pounds.

Because of weight and clearance requirements, however, the route of the shipment was round about. A check of practically every foot of the way was made to determine if temporary obstructions could be removed to allow the load to pass. From Schenectady to Wilkes-Barre, Pa., the car traveled on the Delaware & Hudson. From Wilkes-Barre, the car was sent to Hagerstown, Md., on the Pennsylvania Railroad, where it was turned over to the Western Maryland Railroad. After an extensive detour, it was delivered back to the Pennsylvania on its main line just south of the Baltimore tunnels, which were the principal reasons for the complicated routing. From there it was carried directly to the power company's siding in the District of Columbia.



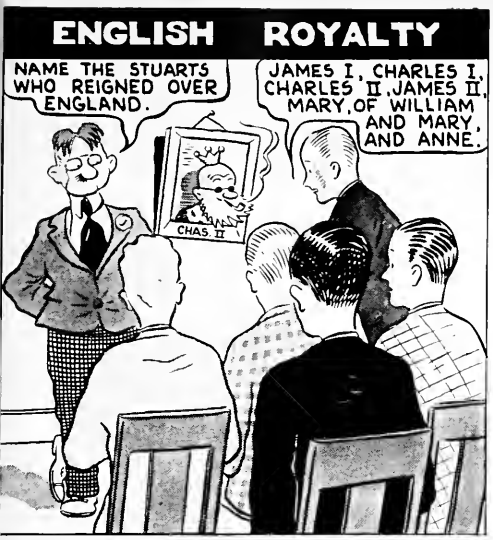
FISH LIFE SAVER

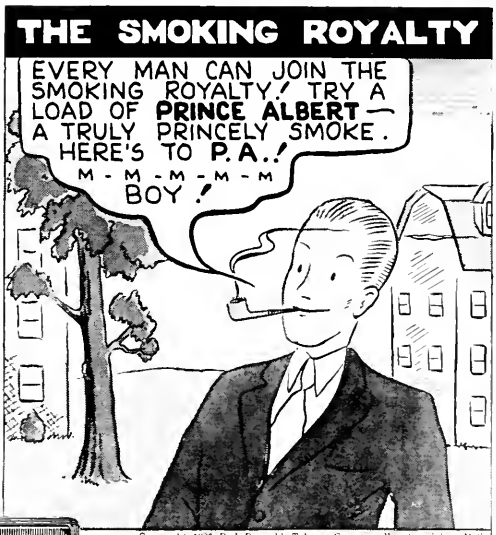
THE people in the New York Aquarium were very unhappy. Many of their rare fish were dying of a mysterious malady. An investigation showed that the water pumped into the tanks contained contaminating metal salts, and that these salts came from the metal pumps in the system.

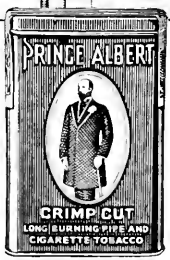
They appealed to the H. A. Smith Pump & Motor Company for help. Mr. Smith began testing all the nonmetallic substances available for making pumps. He tried 14 materials and found that General Electric Textolite was the only one that would prevent this pollution of the water and at the same time make a satisfactory pump.

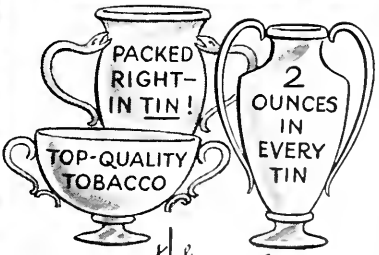
Engineers of the General Electric Plastics Department were called in, and a new pump was designed, using five different grades of Textolite. The pump was so constructed that no water can come into contact with metal.

96-149FBI









PRINCE ALBERT

the national joy smoke

WE ASKED SPORTS CHAMPIONS

"IS THIS FACT IMPORTANT TO YOU?"

"CAMELS ARE MADE FROM FINER, MORE EXPENSIVE TOBACCOS — TURKISH AND DOMESTIC — THAN ANY OTHER POPULAR BRAND."

(SIGNED) R. J. REYNOLDS TOBACCO COMPANY
WINSTON-SALEM, NORTH CAROLINA

FLAVOR! "A Camel tastes like a million dollars!" Ellsworth Vines, Jr., tennis champion, told us. "That rich, mellow flavor appeals to my taste," he continued, "and I actually feel a 'lift' from a Camel!"

ENERGY! Helen Hicks, famous woman golf champion, says: "I'm exhausted at the finish of a tournament, but I never mind. I know I can always quickly restore my energy with a Camel—it's a 'lift' I enjoy often!"

VALUE! An answer from Bill Miller, 4 times National Single Sculls Champion: "It's easy to understand why Camels have such mildness and flavor. Camel spends millions more for finer tobaccos. That's value!"

SO MILD! Frank Copeland, billiard champion: "I enjoy smoking all I want. Camels are so mild that they never upset my nerves. When the subject of cigarettes comes up, I say 'I'd walk a mile for a Camel!'"

HEALTHY NERVES! HOLLYWOOD, CALIF.—"Any one who spends much time in water sports can't afford to trifle with jumpy nerves," says Harold ("Stubby") Kruger, Olympic swimmer and water polo star. Above, you see "Stubby" in Hollywood—snapped recently by the color camera. "I smoke a great deal, and Camels don't ever ruffle my nerves," he says.